Electronic Engineering

EE 34 002 *for further details*

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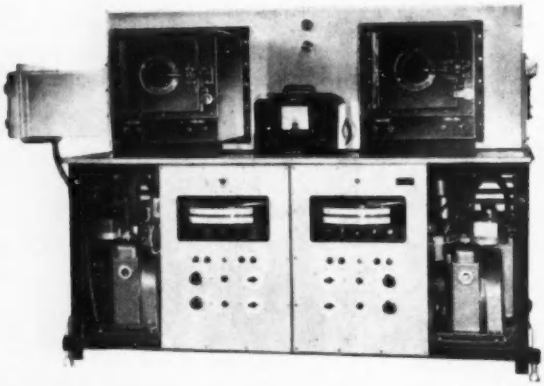
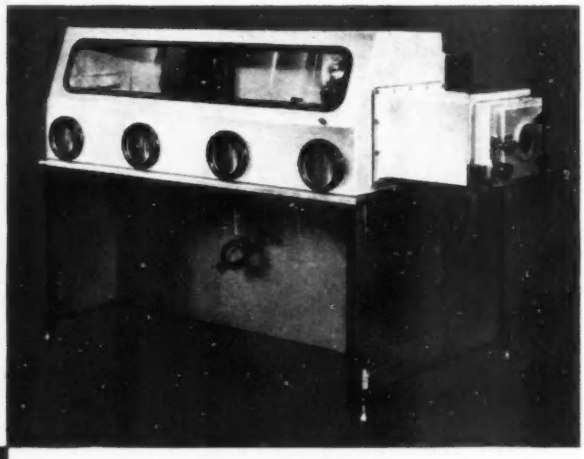
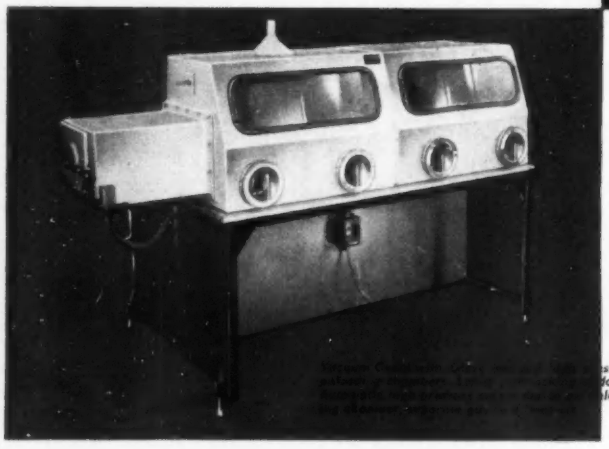
with glove box for semiconductor devices

We design and manufacture Ovens to Customer's special requirements. Should you have any problems in this field our Technical Department is always willing to help you solve them. Vacuum Ovens with temperatures of up to 600°C are also manufactured by us on similar lines but with Sectional Heating and Water-Cooled Ends.

We design, manufacture and supply Vacuum Machinery to major companies in Great Britain and Overseas.







Made throughout in polished stainless steel.
Single action door openings.
Rectangular with self spacings to suit.
Double-ended controls.
Electrical interlocking of air inlet and isolation valve.
Outer cover hermetically sealed.
Temperature Range 0-400 C.
or equivalent F.

Temperature Control: Normal ±7½°C. Special ±1°C.
Internal Spacing 7" x 8" x 18".
(can be altered to special requirements).
Vacuum Range: To 10^{-1} m.m.
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Vol. 33 No. 400

JUNE 1961

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

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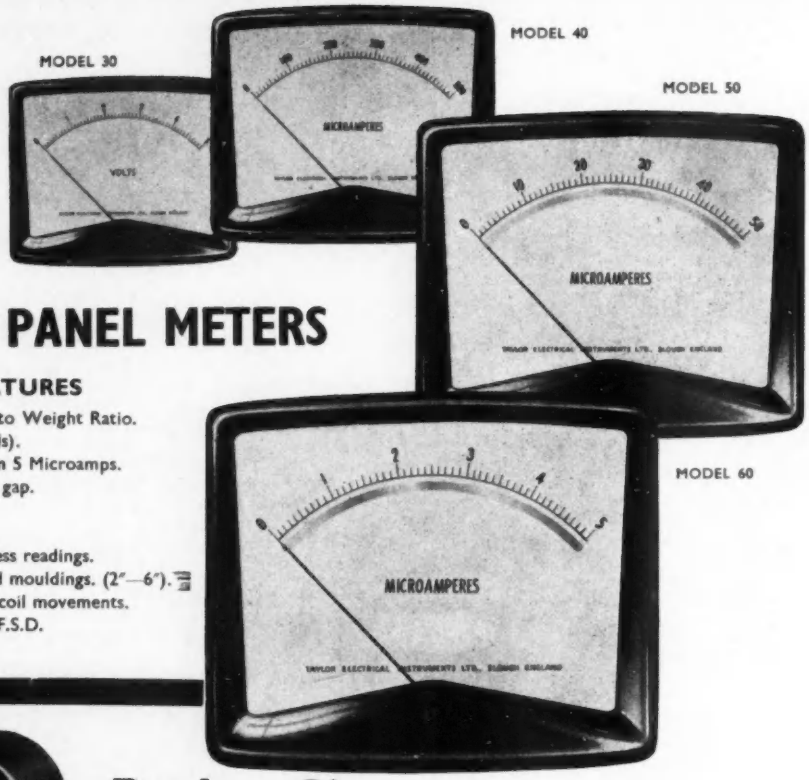

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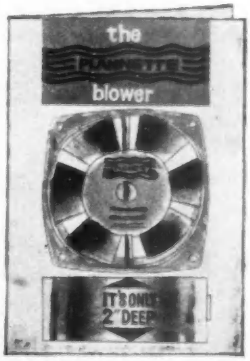

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4½″ delivers 80 c.f.m. at .15 s.w.g.	4½″ delivers 40 c.f.m. at .04 s.w.g.
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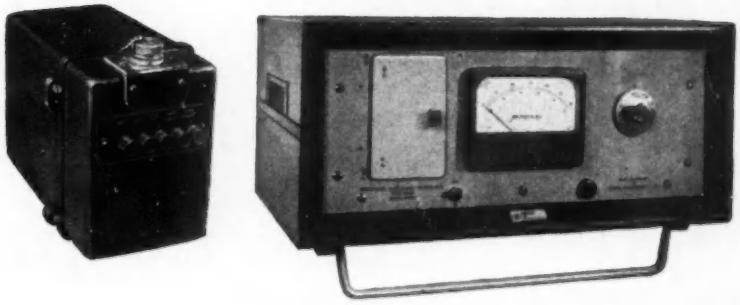
An ionization chamber may be mounted directly on the Electrometer unit in place of the Input connector which may be detached.



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Seven ranges are provided:—

1.	3 mV	5.	300 mV
2.	10 mV	6.	1 V
3.	30 mV	7.	3 V
4.	100 mV		

INPUT RESISTANCE

Three switched input resistors are provided:—

1. 10^8 ohms
2. 10^{10} ohms
3. 10^{12} ohms

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STABILITY

Long-term stability better than ± 100 μV at constant temperature. Short-term stability ± 10 μV.

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110-120 V and 200-250 V, 50-60 c/s. Power consumption 60 watts.

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A jack is provided which enables the instrument to be calibrated against a standard reference potential.

OUTPUTS

A 100 mV recorder can be operated. 215 volts at 5 mA, —105 volts at 2 mA and 6.3 volts at 0.3 A are provided for external equipment.

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Electrometer unit 6″ x 7¼″ x 9½″ (15 x 18.5 x 24 cm). Indicator unit 19″ x 8¾″ x 13″ (48 x 22 x 33 cm).

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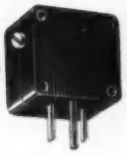

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its precision worm drive assures smooth adjustment without backlash ● its setting remains stable under vibration and shock ● its ratchet mechanism prevents overwinding ● it occupies only 0.11 cu. in. ● can be mounted vertically, in tandem side by side or stacked ● it is specifically designed for today's advanced electronic techniques ● conforms to BSI 3081

and here is its brief specification:

Resistance Range	...	10 Ω to 10k Ω
Tolerance	...	±10%
Rating	...	1w at 20°C, ½w at 70°C
Temperature Range	...	−40 to +70°C Ambient
Weight	...	0.1 oz.
Temp.: Co-eff.	...	Less than 20 p.p.m.
Mechanical Life	...	500 cycles (Slider).

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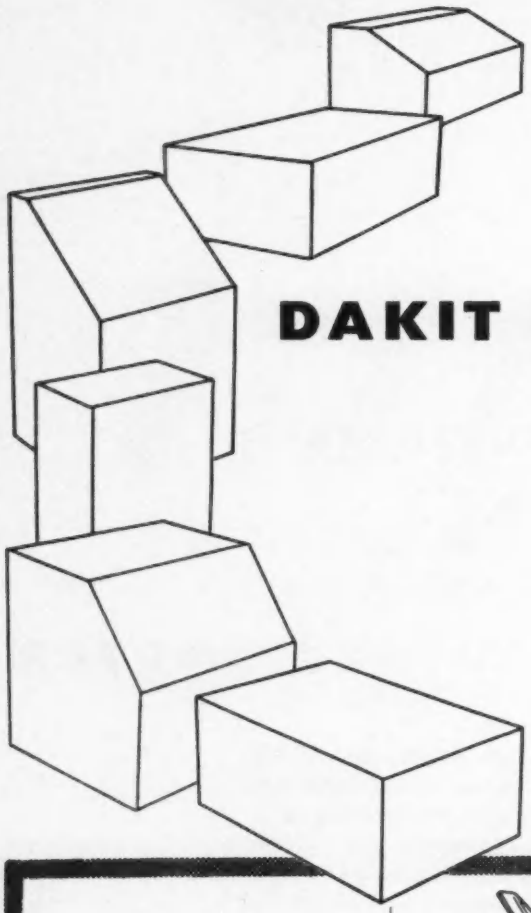
THE SIMPLE TO BUILD INSTRUMENT CABINET CONSTRUCTION SYSTEM

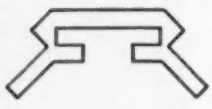
Provisional Patent No. 39574/58

Yet another addition to the Datum range of products

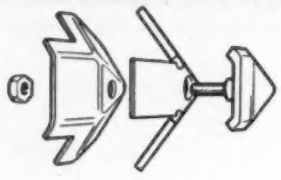


DAKIT ADDS SIMPLICITY TO VERSATILITY

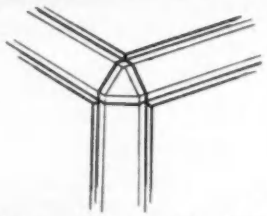
The Dakit method of cabinet construction is the simplest and most efficient of its type yet devised. It enables a wide variety of cabinet shapes and sizes to be built up to your own requirements — quickly and easily. A range of cutting jigs is available, and with a hacksaw and spanner are the only other tools required. The extruded sections are securely clamped in position by a single nut corner fixing, providing a strong, rigid construction. The finished cabinets are most attractive, and where not required for permanent installation may be rapidly dismantled ready for other uses. A trial kit of parts is available — send for full details today.



Aluminium extruded sections supplied in 6 ft. lengths and easily cut to size.



Single nut fixing for quick construction.



Die-cast corner piece giving clean, smooth appearance.

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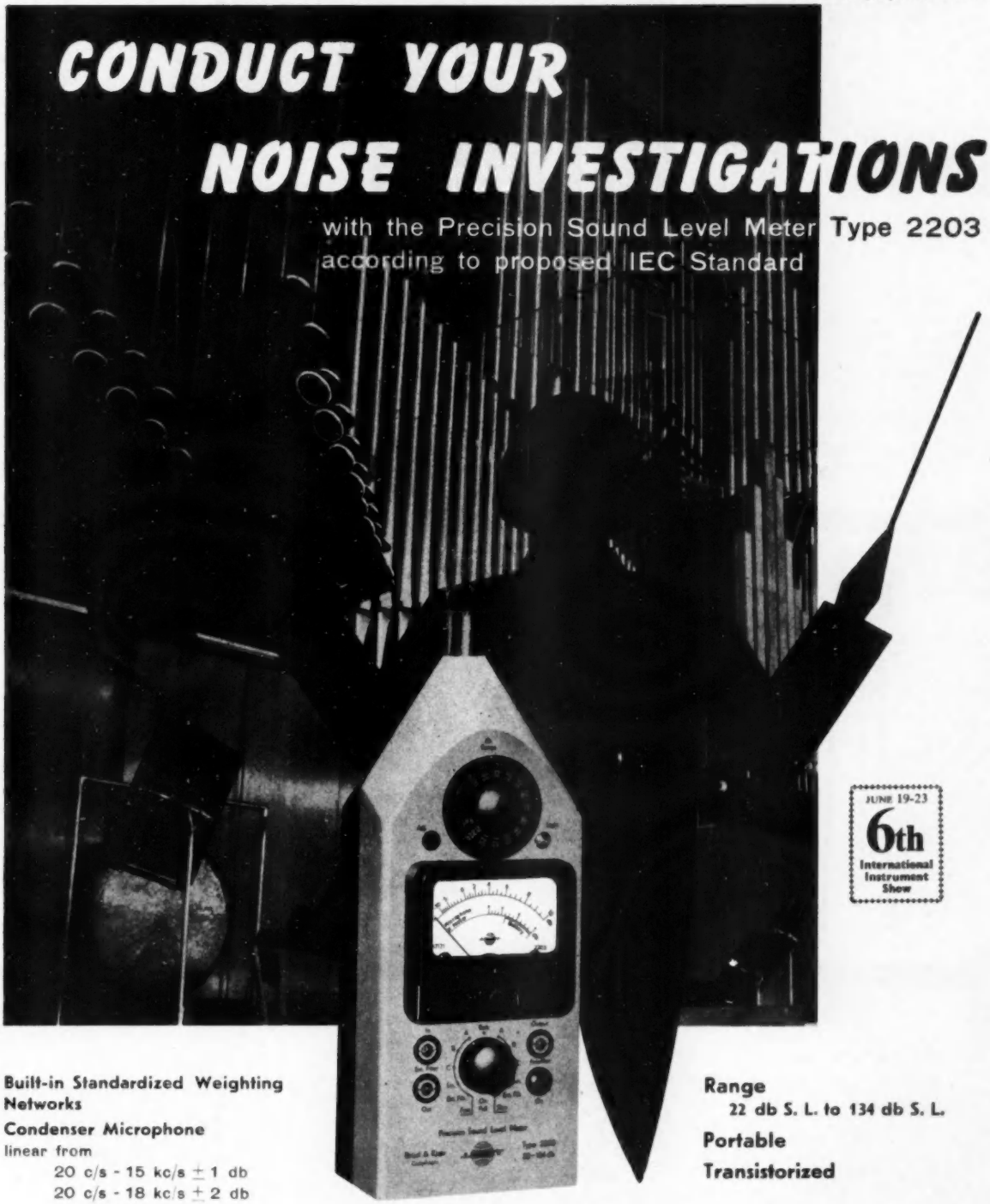

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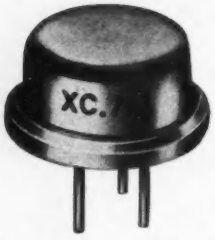

MEDIUM POWER TYPES

HIGH POWER TYPES

		XC703	XC713	XC723
Maximum collector/base voltage (volts)		60	60	60
Maximum emitter/base voltage (volts)		12	12	10
Minimum h_{fe}	(V_{ce} = 4V, I_c = 200 mA)	15	—	—
	(V_{ce} = 4V, I_c = 750 mA)	—	15	—
	(V_{ce} = 4V, I_c = 1.5 A)	—	—	10
Average f_α	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	1.5	—	—
	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	—	1.25	—
	(V_{cb} = 12V, I_c = 100 mA) (Mc/s)	—	—	1

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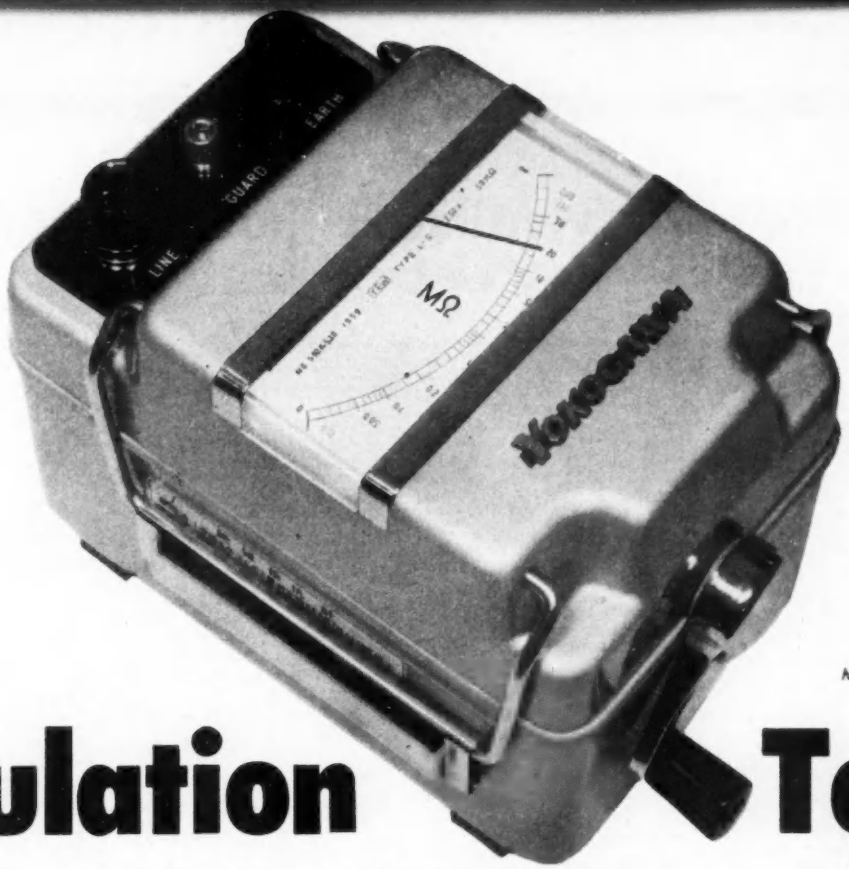

Model L-5

Insulation Tester

EXPANDED SCALE YEW Model **L-5** has a long and electrically expanded scale which covers 5 decades of resistance.

QUICK RESPONSE The quick response of Model **L-5** will help you read the insulation resistance instantly.

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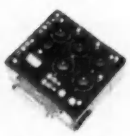
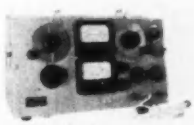
Rated Voltage/ Rated Resistance	Range			Effective Measuring Range
100V / 20M Ω	0~∞Ω	Lowest scale line Highest scale line	2k Ω 100M Ω	0.02~20M Ω
250V / 50M Ω	〃	〃 〃	0.01M Ω 200M Ω	0.05~50M Ω
500V / 100M Ω	〃	〃 〃	0.01M Ω 500M Ω	0.1~100M Ω
500V / 1,000M Ω	〃	〃 〃	0.1M Ω 5,000M Ω	1~1,000M Ω
1,000V / 2,000M Ω	〃	〃 〃	0.5M Ω 10,000M Ω	2~2,000M Ω

Portable Instrument

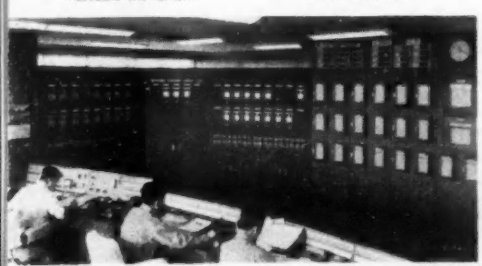
Panel Instrument

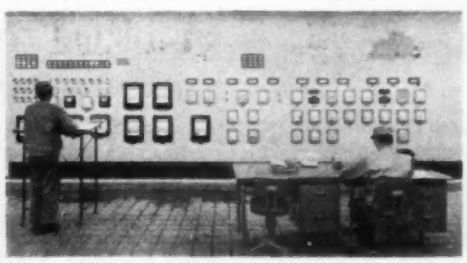

Wheastone Bridge

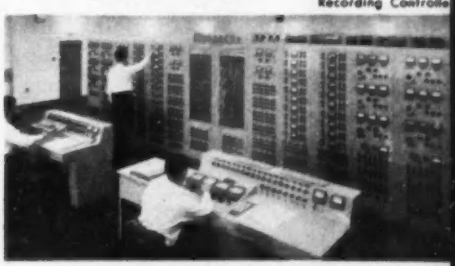
Circuit Tester


Q-Meter

All Electronic Recording Controller


Economic Load Dispatch Computer


Central Control Station of Chemical Plant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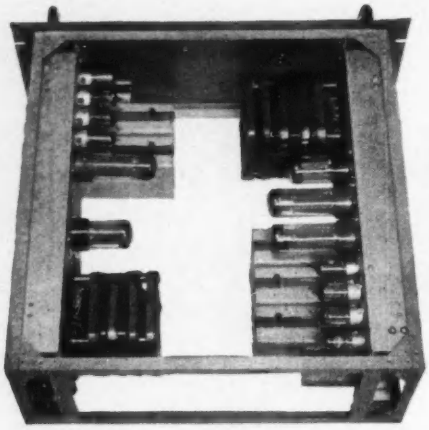
U. K. Sales Agents for Insulation Testers: THE ELECTRICAL INSTRUMENT CO., LTD., Boswell Square, Industrial Estate, Hillington, Glasgow, S.W. 2

regulated - well ventilated - power supplies



Improved Brandenburg design, with wide centre ventilation and easier access to all components. Two of model V300/200 mounted in one suitable frame measuring 17½" × 17½" × 7"4 This shows one of many methods of mounting these units

All models voltage stabilized.

polarity reversible
effective resistance 0·1 ohm
stability against + or − 10% mains change: 0·02%
ripple less than 2mV
input 200/250 volts, 50 cycles.
output a.c. 100 and 200 mA models: 4×6·3V, 1·5A. 350 and 500 mA models: 2×6·3V, 5A. All can be paralleled
dimensions 100 and 200 mA models: 15¾" × 5¾" × 6¾" high. 350 mA models: 15¾" × 7½" × 7½" high. 500 mA models: two chassis, each 15¾" × 5¾" × 6¾" high. Flanged open chassis, with frames available for converting all models to front panel mounting

All prices quoted are for U.K. only—ex-works

200-350 V.		200-350 V.	
100 m/A.	£37 10 0	1 Amp.	£140 0 0
200 m/A.	£48 10 0	2 Amp.	£230 0 0
350 m/A.	£64 0 0		
500 m/A.	£80 0 0	complete with 19" front panel and assembly	

Models below 200 volts can be supplied to order.

new current-stabilized models

type C300

input 200/250 volts, 50 cycles
output current 50-300 m/A, continuously variable
output voltage 500 volts, maximum
stability better than 0·1% for + or − 7% mains variation
drift less than 0·5% for 30 minutes

enquiries are invited for similar specifications

Brochure of Brandenburg voltage-stabilized range also available

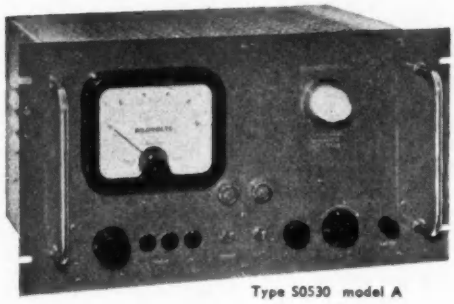
BRANDENBURG LIMITED

139 Sanderstead Road, South Croydon, Surrey. SANderstead 3555/6

Export enquiries should now be directed to Brandenburg Limited at the above address

high voltage regulated power supplies —standard models up to 100 kV.

5, 10, 20 and 30 kilovolt regulated supply



Type S0530 model A

All prices quoted are for U.K. only

Type S0530

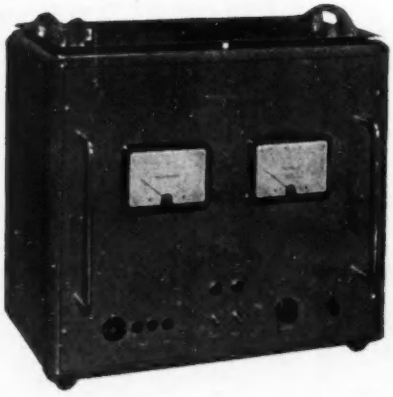
output	1 to 10 kV at 2mA. Model A 2 to 20 kV at 1 mA. Model B 3 to 30 kV at ½ mA. Model C 500 V to 5 kV at 2 mA. Model D
input	200/250 volts, 50 cycles
polarity	positive or negative grounded available
regulation	against full load: better than 0.5% Against mains variations of plus or minus 7%, better than 1%

- 5" Ernest Turner movement
- current metering jack
- standard 19" x 10½" P.O. panel
- for rack mounting or bench use

£135 ex-works

Models A, B and C can be supplied with reversible output polarity at £165

50 kilovolt regulated supply



Type MR50R

Type MR50R

output	5 kV to 50 kV at 1 mA
input	200/250 volts
polarity	reversible
regulation	against full load: better than 1% Against mains variations: +5%,—5%, better than 1%
dimensions	W: 24" H:23" D: 15"

£245 ex-works

100 kilovolt regulated power supply

Type MR100R—3 models

output current	0.5 mA. Model MR100R/500 1 mA. Model MR100R/1
output voltage	10 to 100 kilovolts, continuously variable
polarity	reversible
ripple	0.1%
regulation	no load to full load: better than 1%. Against mains variations of plus or minus 7%, better than 1%
input	200/250 volts, 50 cycles
metering	output voltage and current metered

Brochure on request : for further specifications of this Brandenburg range of standard high voltage equipment, please write for brochure.

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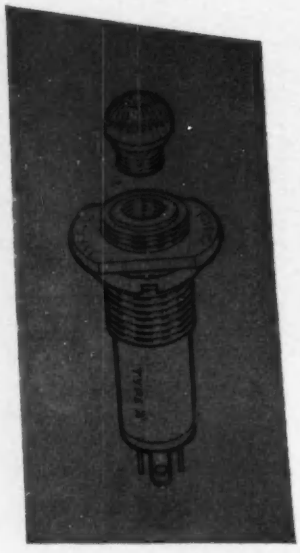
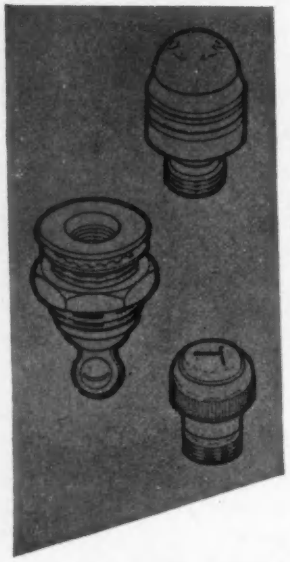
THORN

THORN ELECTRICAL INDUSTRIES LIMITED

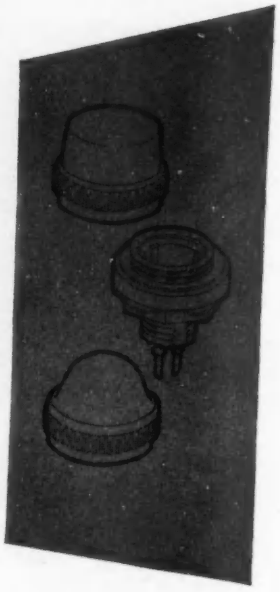
MINIATURE INDICATOR LAMPHOLDERS



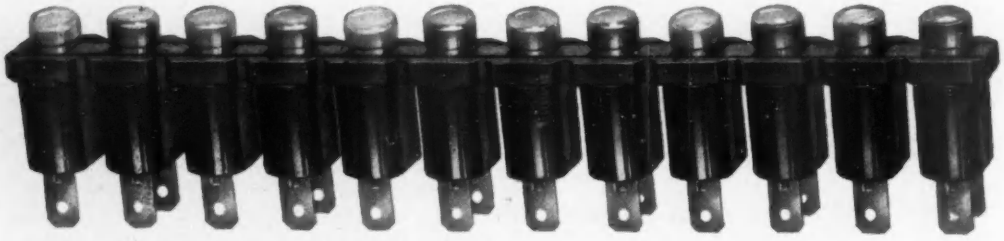
PRESS-TO-TEST SWITCHES. Three or five-terminal versions available; the latter providing 34 circuit variations. Solder tag or screw terminals to choice. All bases will take dimmer, flat top indicator or indicator caps; full range of colours available. The switches are vibration-proof and maintain predetermined contact pressures.



INDICATOR AND DIMMER CAPS AND BASES. Inter-changeability between caps and bases provides maximum flexibility within the range. Wide variety of cap colours available; screw or solder terminals, panel return or insulated, to choice. Dimmer has metal rotary shutter with built in stops. Indicator caps are facet cut for maximum visibility. The Flat Top Indicator can carry an engraved legend.



MINIATURE SEALED GLASS LAMPHOLDERS. Designed to ensure reliability under severe conditions of service. Waterproof, pressurised and shockproof, they are primarily intended for aircraft, armoured vehicles and military equipment. Dimmer and Indicator Caps available in a wide range of colours. 2 pole lamp holder body.



MULTI-SOCKET INDICATORS. Ideal for use with computers and illuminated read-out devices. They are produced in strips of twelve sockets with $\frac{1}{2}$ or $\frac{3}{4}$ inch centres.

An Easy mount single socket similar to the indicator strip is also available, and can be used separately or in conjunction with multi strip-socket.

Lamps are available in 6, 12 or 28 volts, 35—45 mA, with a burning life of 3,000—5,000 hours. Plastic nylon caps are obtainable in White, Red, Yellow or Green, these fit directly over the lamp and eliminate the need for prismatic jewels.

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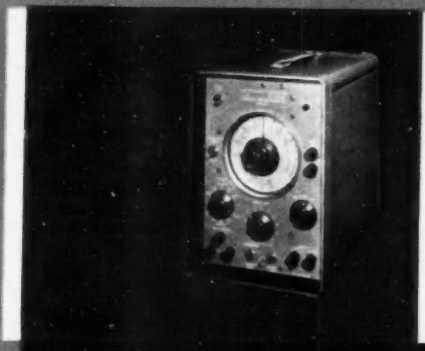
DTV/K



Video Oscillator TYPE TF 885A/1.
25 c/s to 12 Mc/s.

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With more than 120 Marconi Instruments from V.L.F. to S.H.F., we are confident that we can provide the facilities you require at the frequencies you are working on.

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FOR ELECTRONIC MEASUREMENT

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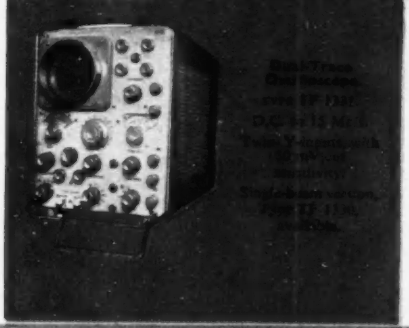
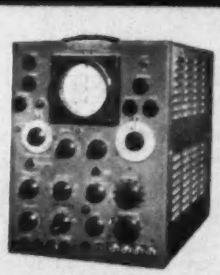


L.F. Oscilloscope
TYPE TF 1159.
15 c/s to 20 kc/s.
4 mV/cm sensitivity.
High resolution.
17-inch tube.



Television Measuring Oscilloscope
TYPE TF 1277.
D.C. to 10 Mc/s.
Measures K factor, sine-squared pulses, and black-level stability.
Includes line-strobe facility.

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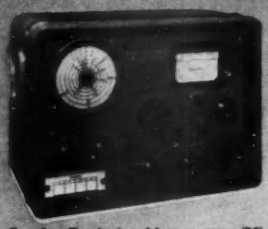
Low-Capacitance Bridge TYPE TF 1342.
0.002 μμF to 1,111 μμF at 1 kc/s.

IMP



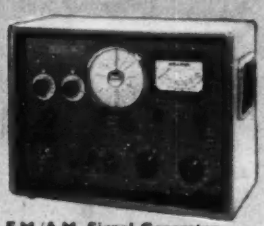
Carrier Deviation Meter TYPE TF 791D.
Carrier: 4 to 1,024 Mc/s.
Deviation: 10 c/s to 125 kc/s.

MODULATI

OVER 120 MARCONI INSTRUMENTS FROM VLF

SIGNAL G

Standard Signal Generator TYPE TF 144H.
10 kc/s to 72 Mc/s. A.M. to 80%.



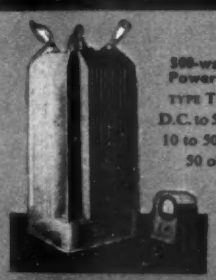
F.M./A.M. Signal Generator
TYPE TF 995A/2M.
1.5 to 220 Mc/s. F.M. up to 75 kc/s deviation.
A.M. to 50%.

F.M. Signal Generator TYPE TF 1066B.
10 to 470 Mc/s. F.M. to 100 kc/s deviation.

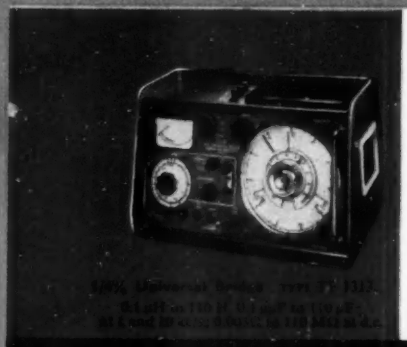
POWER METERS

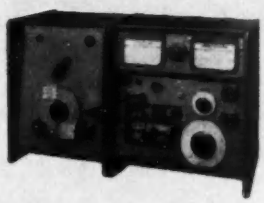
10-watt A.F. Power Meter TYPE TF 893A.
20 c/s to 35 kc/s; 20 μW to 10 watts;
2.5 ohms to 20 kΩ.

25-watt R.F. Power Meter
TYPE TF 1152A.
D.C. to 500 Mc/s;
0.5 to 25 watts
50- or 75-ohm versions.



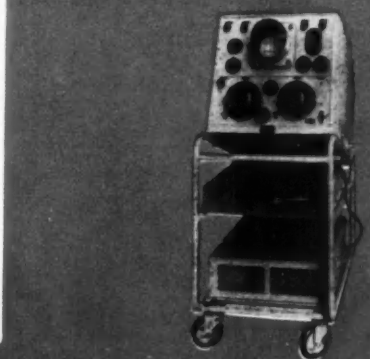
500-watt R.F. Power Meter
TYPE TF 1205.
D.C. to 500 Mc/s
10 to 500 watts
50 ohms.



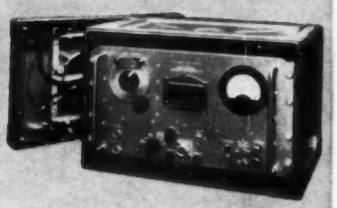


Circuit Magnification Meter TYPE TF 1245.
Q from 5 to 1,000, 1 kc/s to 300 Mc/s.
External oscillators.

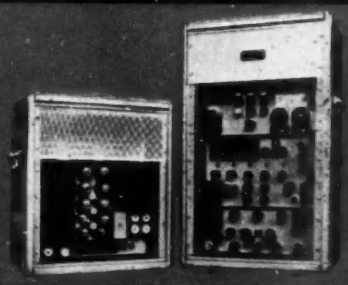
DANCE BRIDGES



M.F. Spectrum Analyser TYPE OA 1094.
3 to 30 Mc/s, A.M. or F.M.
Optional I.F. extension unit.
Manufactured under G.P.O. licence.



F.M. Deviation Meter TYPE TF 928.
Carrier: 20 to 500 Mc/s.
Deviation: to 400 kc/s.



Television Transmitter Sideband Analyser
TYPE OA 1241.
Provides composite television test signal for measuring overall response of transmitters or video amplifiers.

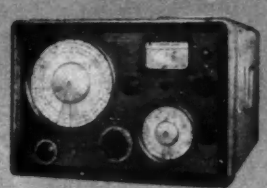
N METERS

SPECTRUM ANALYSERS

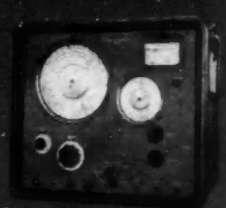
TO SHF

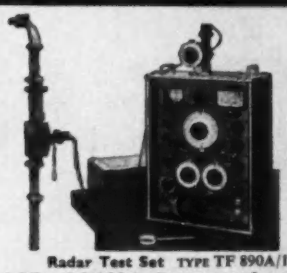
Designed and manufactured by specialists with 25 years experience of research and development in the field of electronic measurement.

NERATORS



U.H.F. Signal Generator TYPE TF 1060.
450 to 1,250 Mc/s. Sine a.m. and pulse modulation.





Radar Test Set TYPE TF 890A/1.
8,500 to 9,680 Mc/s. Incorporates f.m. signal generator, wavemeter, power monitor, directive feed assembly and spectrum analyser.

VOLTMETERS

A.C. Microvoltmeter TYPE TF 1373.
50 c/s to 1 Mc/s; 5 μV to 15 volts.

Suppressed-Zero Voltmeter TYPE TF 1377.
10 mV to 500 volts d.c., and small changes down to 1 mV in 100 volts.
Optional a.f. and r.f. probes.

Vacuum Tube Voltmeter TYPE TF 1041B.
25 mV to 300 V (20 c/s to 1,500 Mc/s); 10 mV to 1,000 V d.c.; R from 0.02Ω to 500 MΩ.
Optional voltage multipliers.

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10-Mc/s Electronic Counter TYPE TF 1345/2.
Stability: 3 in 10^9.
Range of optional plug-in units.

Electronic Counter TYPE TF 1165.
Counts pulses or sinewaves up to 1 Mc/s.
Optional Timing Oscillator.

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AN ENGINEER CHECKING THE FREQUENCY STABILITY OF THE F.M./A.M. SIGNAL GENERATOR, TF 995A/5, USING MARCONI INSTRUMENTS DIGITAL FREQUENCY MEASURING AND RECORDING EQUIPMENT

Decoder TYPE TF 1392.
Plug-in units for in-line readout, and for driving printers or recorders.

Please send details of the following, marked X *If your requirements are not covered by this list, please state your special interest below*

Signal Generators	Modulation Meters	Voltmeters
Noise Generators	Distortion Analysers and Meters	Impedance Bridges
Oscillators	Spectrum Analysers	Dielectric and 'Q' Meters
Oscilloscopes	Frequency Counters and Meters	'MARCONI INSTRUMENTATION' a free quarterly technical bulletin
Pulse Generators	Power Meters	

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Representation in 68 countries

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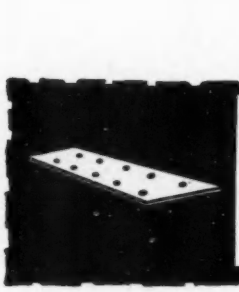
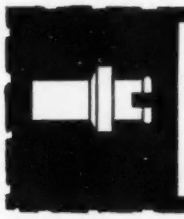
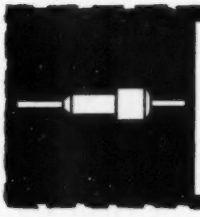


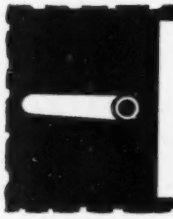
TERMINAL BOARDS



LUGS



MOULDED INSULATORS



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Harwin *make* components—*specialise* in components. Lugs, moulded insulators, terminal boards and chassis furnishings. 'Off-the-shelf' or to special design.
The *quality* of every Harwin component is the product of experienced, precision manufacture and rigid inspection—meeting, and in many cases surpassing standard specifications. In addition, Harwin *service* and *specialisation* in fulfilling individual needs is something to be experienced—talk over *your* component problems with Harwin and be sure of the *best* and most *effective* answer.

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OVER 200
TYPES AVAILABLE!

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To:
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✳CO-AX cables
Airflex cables
RG cables
Minicables

✳ ULTRA LOW
CAPACITANCE & ATTENUATION

TYPE	pF/ft	IMPED. Ω	O.D.
C1	7.3	150	.36"
C11	6.3	173	.36"
C2	6.3	171	.44"
C22	5.5	184	.44"
C3	5.4	197	.64"
C33	4.8	220	.64"
C4	4.6	229	1.03"
C44	4.1	252	1.03"

38 STOCK TYPES
for your standard or special applications

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FOR THE ATTENTION OF..... ● DEPARTMENT .....

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30 May – 2 June, 1961

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RADIO AND ELECTRONIC COMPONENT SHOW

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Stabilized D.C. power supply Type PP2

Advance laboratory-grade power supplies with their electronic protection against overload conditions and high degree of stabilization are eminently suitable for research and development work, particularly in the sphere of transistorised equipment. *Leaflet No. B105 available on request.*

- OUTPUT CONTINUOUSLY VARIABLE FROM 0 TO 50V.
- MAXIMUM LOAD CURRENT 10A.
- OUTPUT IMPEDANCE: LESS THAN 0.2 OHMS.
- RIPPLE LESS THAN 0.5MV PEAK TO PEAK.
- ADJUSTABLE ELECTRONIC CUT-OUT.
- NETT PRICE IN U.K. £220.

A brief indication of the remainder of the range:

PP1 *HT, Bias, and LT supplies for thermionic valves. Nett price in U.K. £160. Leaflet No. DB103*

PP3 *Two independent output voltages 0-30 V d.c. 1A each continuously variable. Nett price in U.K. £120. Leaflet No. DC62*

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EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

EE 34 025 *for further details*

a calculation of mathematicians

No. 2 ARCHIMEDES

Archimedes was a mathematician and an inventor. He discovered things. He discovered that when he got into a bath full of water it overflowed and was so overjoyed that he ran down the street, without any clothes on, shouting "Eureka". The passers-by also discovered things. Archimedes invented the screw. He didn't write "The Turn of the Screw"—that was Henry James. Archimedes' screw was used for raising water. As most people are more interested in raising the wind it never went into large scale production. This explains why Archimedes didn't have to perfect a counting machine. He left it over for Counting Instruments about 2000 years later.

Archimedes wasn't the only one who went in for display. Take C.I. In-line Digital Display (most people are only too anxious to once they've had them demonstrated). Any number from 1 to 12, or any combination of letters, symbols or fractions, in white or colour can be projected on to a screen for one plane presentation. In three sizes, ¾", 1" or 3¾" high characters, we show here the series 640 (3¾") job with a 1" standard model for comparison. Let no one say we haven't progressed in 2,000 years.

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U50/15	8—50	10.4	15	15*	6.5	2.75
U80/15	16—80	10.4	15	20*	6.5	3.30
U200/8	5.5—206	17	8	20†	9.5	2.49
U200/10	5.5—206	17	10	20†	9.5	3.50

* Up to 30 Mc/s † Up to 20 Mc/s

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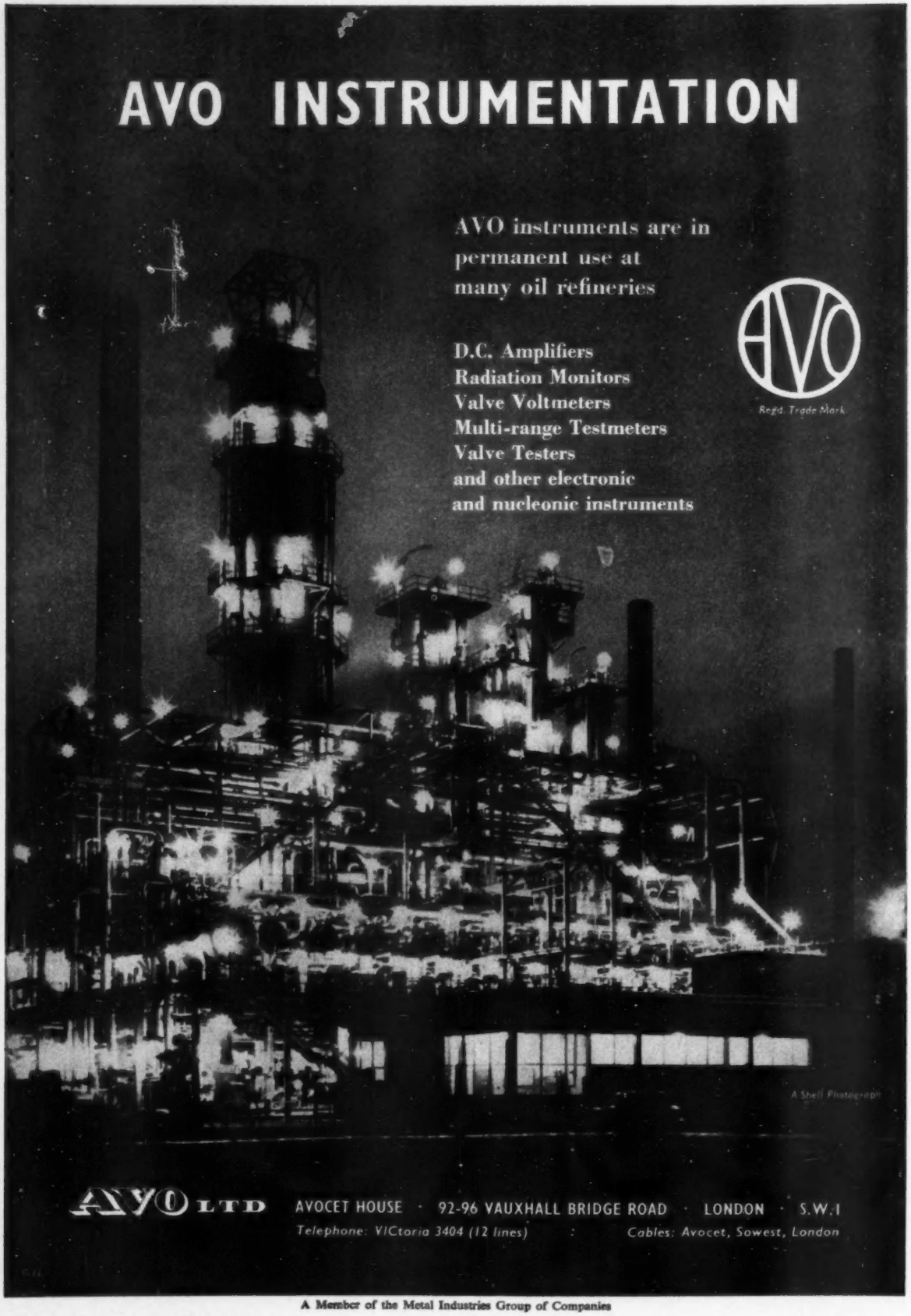

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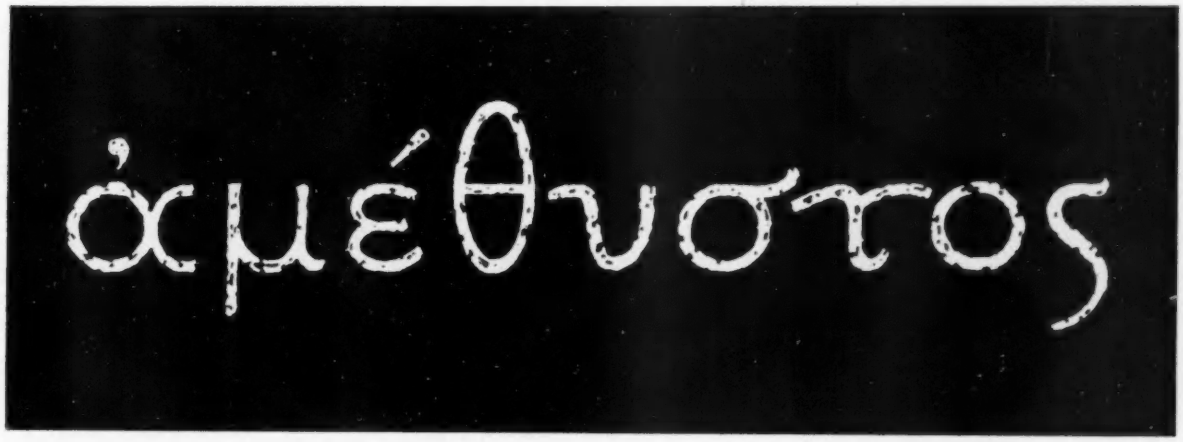
The Greeks

had a

use for it



Ancient Greeks used quartz for carving, intaglios and seals. Literal translation of the Greek symbols, however, means 'not drunken'—evidence of the superstition that quartz or amethyst gave the wearer immunity against drunkenness.

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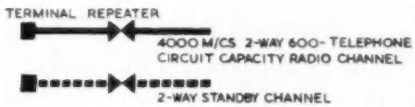
STC are supplying main-line microwave telephone systems to 18 countries and have already supplied systems with a capacity of over 4½ million telephone circuit miles and over 5000 television channel miles.



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SOUTH AFRICA—ONE OF 18 COUNTRIES HAVING STC MICROWAVE SYSTEMS

STC have supplied and installed the first 600 circuit, 4000 Mc/s microwave telephone system for the South African Post Office. Duplicated radio channels with automatic baseband switching are provided over the route between Johannesburg and Klerksdorp, approximately 110 miles (177 km).

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Aerial equipment
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Transmission Test equipment
High quality music programme equipment
VHF radio links and yagi aerials
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has lower initial permeability than Permalloy 'C' but has a higher value of flux density. It is suitable for use where high permeability to an alternating field superimposed upon a steady polarising field is required.

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for very high resistivity without undue lowering of the maximum flux density. Variation of permeability with frequency is small. Ideal for H.F. applications.

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for high permeability with a very high value of maximum flux density. Finds special application for use as high quality receiver diaphrams, also motor generators and servo-mechanisms in aircraft where weight and volume are important factors.

PHYSICAL PROPERTIES AND GENERAL MAGNETIC CHARACTERISTICS

	Permalloy 'B'	Permalloy 'C'	Permalloy 'D'	Permalloy 'F'	V-Permendur
Specific Gravity	8.3	8.8	8.15	8.4	8.2
Electrical resistivity—microhms per cm cube	55	60	90	26	26
Initial permeability μ_o	2 000 to 4 000	15 000 to 40 000	1 800 to 3 000	400 to 1 000	700 to 1 000
Maximum permeability μ_{max}	15 000 to 40 000	50 000 to 150 000	12 000 to 20 000	200 000 to 400 000	3 000 to 6 000
Magnetising force for μ_{max}-oersteds	0.20 to 0.40	0.025 to 0.04	0.2 to 0.5	0.03 to 0.10	2.0 to 6.0
Maximum flux density-gauss	16 000	8 000	13 000	14 000	24 000
Coercive force in oersteds for B_{max}=5 000 gauss	0.15	0.03	0·15	0.05*	2.3†
Remanence in gauss for B_{max}=5 000 gauss	4 000	3 500	3 500	13 000*	16 000†
Hysteresis loss in ergs/cc/cycle for B_{max}=5 000 gauss	160	40	200	220*	12 500†
Total loss in watts/lb for B_{max}=5 000 gauss 50 c/s 0.015 in. sheet	0.11	0.04	0.2	0.3*	4†

* for B_{max}=14 000 gauss † for B_{max}=20 000 gauss

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General purpose; high efficiency at high impedance levels	GD8
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Detector up to 50 Mc/s; suitable for transistor circuits	GD11
Audio and video detector	GD12
Video detector at 36 Mc/s	GD13
A.F.C. in F.M. receivers	GD14
F.M. Ratio detector	GD15 (matched pair)
Audio detector at 38 Mc/s	GD16

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A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	PEAK THRUST
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG108 Mk.II	5,300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

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For close on 20 years the Model 44A Precision Multi Range Meter has been adopted as a standard for checking or calibrating single range meters. It is also widely used in research laboratories where very precise measurements of voltage or current have to be made. Accuracy on the 20 d.c. ranges conforms to B.S.S. 89:1954; that is, 0.3% F.S.D. on all voltage ranges (1V—1000V) and 0.5% on the current ranges (1mA to 10A). On the corresponding a.c. ranges there is no B.S. specification but the errors do not exceed 0.5%. Although a precision instrument, the Model 44A is very robust and will stand quite severe handling. A patented moving coil cut-out protects the meter movement from accidental forward or reverse overloads. So reliable has the Model 44A proved in practice, that one well-known firm has more than 120 instruments in use throughout its works and laboratories. The price is £118.

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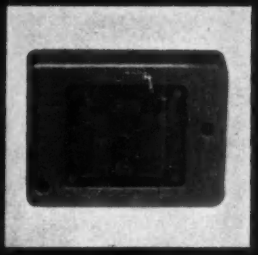
new 'Silcoset' rubbers from I.C.I.



I.C.I. announces the addition of two new 'Silcoset' rubbers to its range of room-temperature-curing silicone rubbers.

'Silcoset' 103 is a white solvent-free paste suitable for use where absence of colour is important—in applications concerned with foodstuffs, for example.

'Silcoset' 104 is a thixotropic solvent-free paste of particular value in caulking and sealing applications.

Both 'SILCOSET' 103 and 'SILCOSET' 104 cure at room temperature to resilient silicone rubbers, after a curing agent has been added. I.C.I. offers four curing agents: A—standard; B—slow; C—non-toxic; D—fast.

'Silcoset' rubbers are being used for potting and encapsulating electronic parts, 'in situ' coating of conveyor belting, replacement parts in surgery, flexible moulds for resin casting, e.g., model-making.

'Silcoset' rubbers may be just what you've been waiting for. Find out more about them—write to your nearest I.C.I. Sales Office or to:

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Plessey Telecommunications equipment is employed on a world-wide basis by Civil Aviation Authorities; similarly, it is used internationally by Meteorological Services.

Behind this achievement are the extensive prototype and quality manufacturing resources of the Telecommunications Division, inspired by the work of a unique research and development organisation. The Company recognises the need to segregate advanced thinking from the hustle and distraction of the factory. Accordingly, in addition to the Group Research Laboratories at Roke Manor and other specialised research centres already existing in the U.K., extremely well equipped laboratories have recently been established at West Leigh for advanced Telecommunications studies.

In these establishments, the next generation of telecommunications equipment is already taking shape.

In close support at all times are the complete resources of the Plessey Group of Companies, which include unrivalled tool making and machining facilities, a full range of environmental testing and production laboratories, and the service of the metallurgical and chemical laboratories at Caswell.

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MAIN TYPES (Typical Operating Conditions)

Face Diameter	5″	5″	5″	5″	5″	4″	4″	3″
Type No.	255C	SE5A	SE5B	SE5D	SE5E	SE4A	SE4B	SE3A
Final anode voltage	12	10kv	10kv	10kv*	10kv	8kv	4kv	4kv
& PDA Ratio	4.8	6.67	6.67	12	12	4	4	4
Screen Area cms x cms	8 x 10	6 x 10	4 x 10	4 x 10	6 x 10	5 x 8	5 x 8	5 x 6
Y sens. v/cm	15	10	7	3.5	5.5	15	7.5	7.5
X sens. v/cm	33	30	30	14	14	48	25	27

* at 7.5kv Sy 2.50 v/cm Sx. 10 v/cm Sensibility better than 0.14 v/line width

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NEW MULLARD TRANSMITTING VALVES

MULLARD introduce seven additions to their extensive range of transmitting valves. These new developments, for use in television transmission, mobile radio communications and microwave links, combine the advantages of the latest manufacturing techniques together with long-term experience gained in operational service.

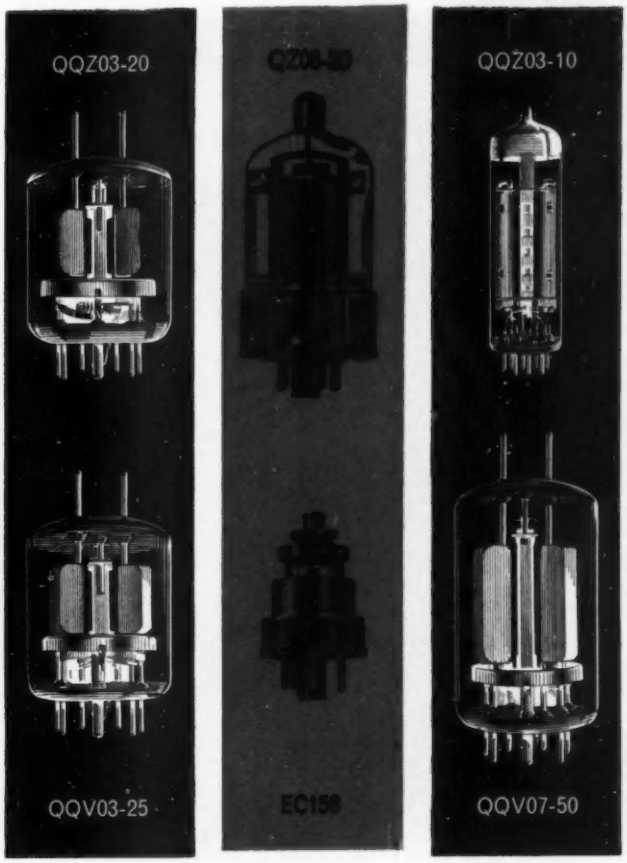
TELEVISION TRANSMISSION

Coaxial u.h.f. power tetrode QY3-1000A, with ceramic construction, for use as a Class B or Class C amplifier at frequencies up to 1Gc/s. As an amplifier for television service the QY3-1000A will provide an output power of 1.28kW at a frequency of 900 Mc/s and 1.76kW at 600Mc/s.

MOBILE RADIO

Three new quick heating versions of existing tetrode transmitting valves. The use of these valves, the QQZ03-10, QQZ03-20, and the QZ06-20 will permit considerable economy in transmitter standby power consumption and will also effect a reduction of chassis ambient temperature. All three valves deliver more than 70% of maximum output power within one second of switching on.

	Power output at full ratings.		Max. operating frequency
	(W)	(Mc/s)	(Mc/s)
QQZ03-10	13	200	225
QQZ03-20	45	200	500
QZ06-20	70	60	175



COMMUNICATIONS

Two new double tetrodes **QQV07-50** and **QQV03-25** meet the demand for increased anode dissipation and can be incorporated in equipments requiring output powers of 70W and 35W respectively, including equipment where the **QQV03-20A** and **QQV06-40A** are being used.

MICROWAVE LINKS

EC158 disc seal s.h.f. triode for microwave link communication equipment capable of 5W output power at 4Gc/s (50 Mc/s bandwidth at −0.1dB). The unique performance of this most advanced valve is made possible by the incorporation of a special dispenser cathode.

FURTHER INFORMATION

Further information on all these devices is available, please quote reference **D4136** when writing to Mullard House.

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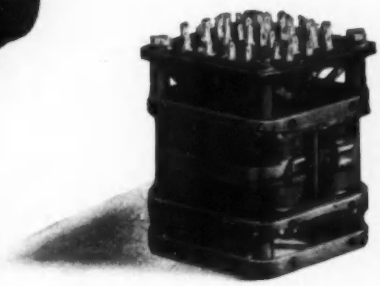

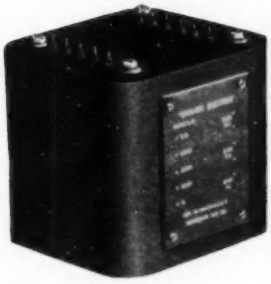

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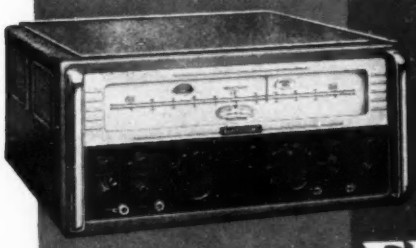

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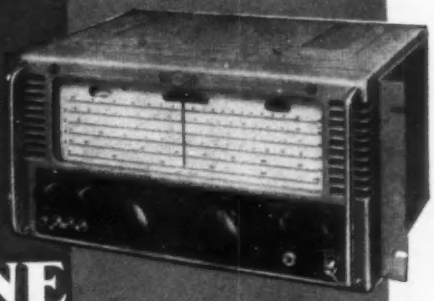

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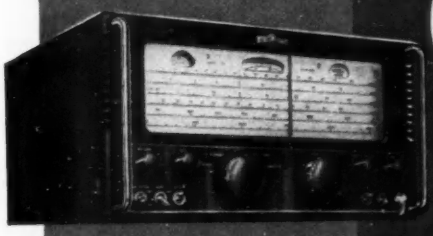

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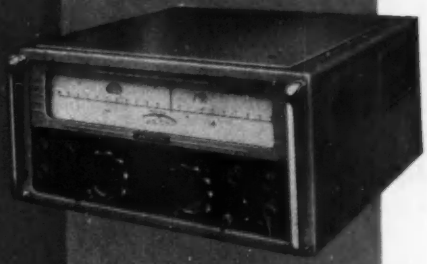

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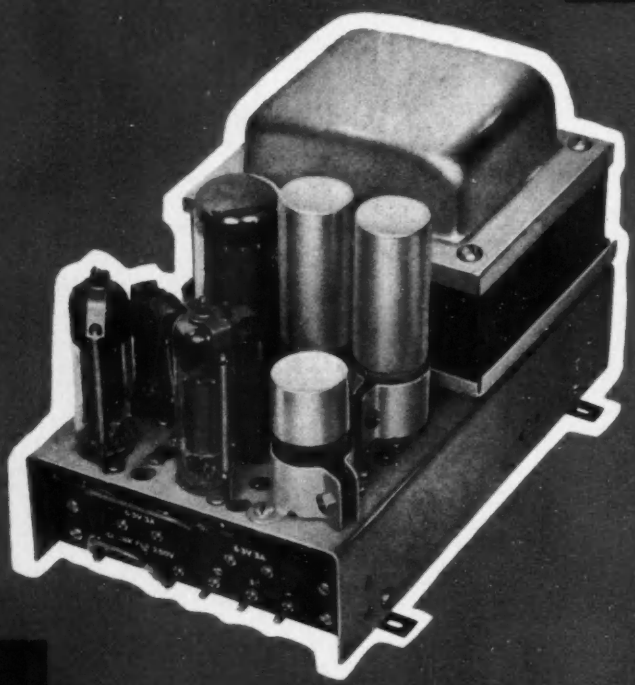

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The illustration shows the Servomex ACII Mark IIB with wooden ends. These are an optional extra.

£99 in 1953

The Servomex ACII Mark IIB Voltage Stabiliser is a very remarkable instrument. *Remarkable* because it has held the original 1953 price of earlier models despite increased costs throughout the Industry. *Remarkable* because the materials in each instrument, mostly to military specifications, cost as much as £47. *Remarkable* because 39 man hours go into the production of each unit and the resulting standard

£99 in 1961

product is acceptable to military and government inspectors. *Remarkable* because although ruggedised to stand up to 40g, and tropicalised for service anywhere in the world its price is no higher than for ordinary commercial quality. *Remember* Servomex make only one quality — The BEST that money can buy.

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TA 5248

9 Mc/s

The versatility of the Serviscope* range of portable and rack-mounted oscilloscopes has now been increased by the introduction of two new instruments... PA2, a Twin Channel Pre-amplifier, and S42A, a Wide-Band Serviscope. The Pre-amplifier, though designed primarily for the Double-beam Serviscope, D31, is quite suitable for any oscilloscope in the Serviscope range.

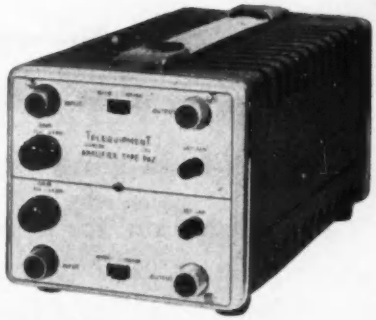
Used in conjunction, the two new instruments give exceptionally high performance—DC 100mV/cm at 9Mc/s, and 10mV/cm at 0.5Mc/s, AC 100μV/cm at 150Kc/s—at a total cost of less than £130.

S42A Wide-range High-performance Serviscope

The S42A carries the development of the Serviscope a stage further. Y amplifier bandwidth has been increased to 9Mc/s at the normal gain of 100mV per cm. whilst preserving all the normal features of the S42, including the 10 x gain facility at limited bandwidth. This feature should make the oscilloscope ideally suited to work at the highest video frequencies, and the faster rise time will increase its usefulness in pulse circuit investigation.

The ingenious extendible light hood, formerly supplied as an extra, is now standard with both S42 and S42A.

100μV



PA2 Twin Channel Pre-amplifier

A high-gain pre-amplifier capable of increasing sensitivity by 100 on each independent channel, intended for applications which need exceptionally high sensitivity in, for example, the medical, biological and electro-mechanical fields. The power supply is self-contained, and gain is stabilised against variations in supply voltage. The PA2 may be switched out of circuit, allowing direct input to the oscilloscope without disconnecting.

TELEQUIPMENT

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James A. Jobling & Co. Ltd. are now manufacturing a range of components for the electronic and allied industries. These components are sold under the trade mark 'Electrosil'.

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The products, which will be distributed throughout the United Kingdom, will include a most comprehensive range of:

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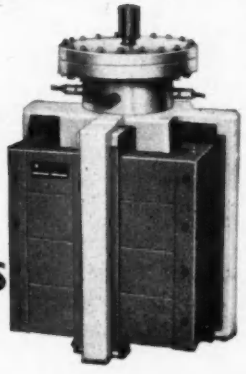

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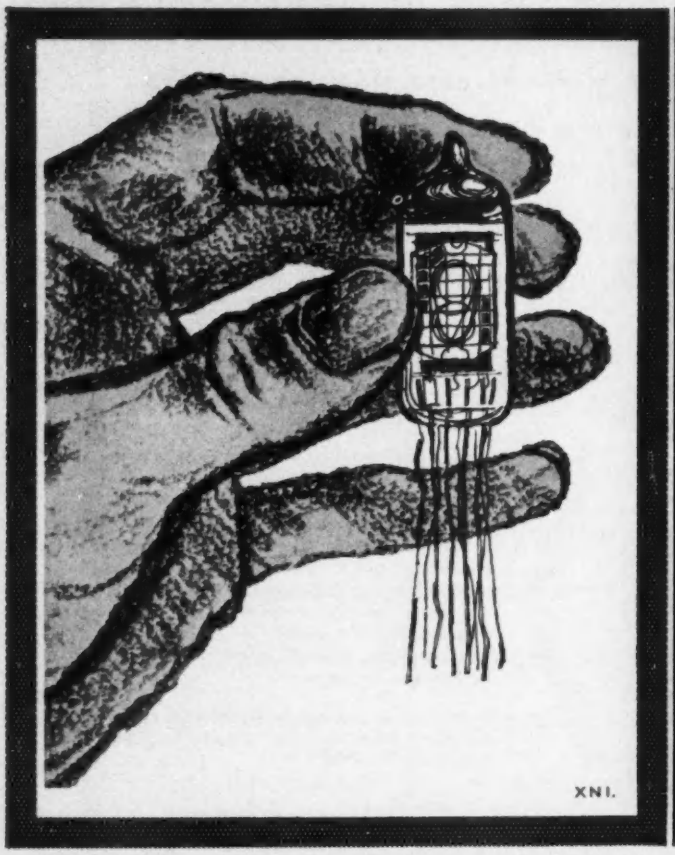

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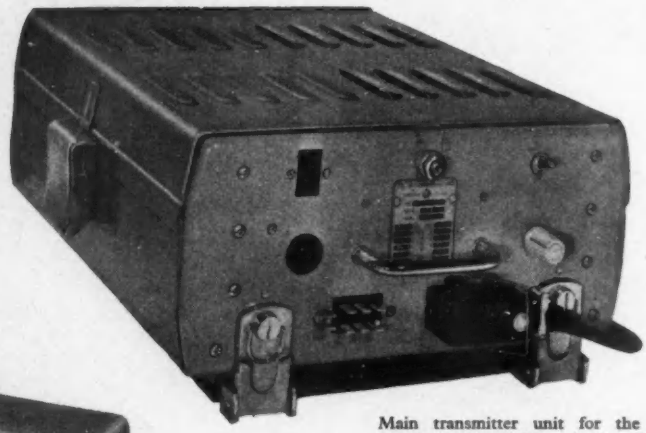

Main transmitter unit for the Pye (PTC 2107) V.H.F., A.M. Mobile Radiotelephone, made by Pye Telecommunications Ltd., Cambridge, in which a number of components made from 'Fluon' p.t.f.e. is used.

Pye use 'Fluon' components for maximum reliability in 'Ranger' V.H.F. radiotelephones

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Pye 'Ranger' v.h.f. radiotelephones are designed for continuous operation under the worst possible climatic conditions. To ensure maximum reliability, Pye use a number of components made from 'Fluon' p.t.f.e. in these sets. 'Fluon', which is an I.C.I. plastic material, is the best of all solid dielectrics, with a very low power factor and permittivity, and is a very good insulator. In addition, 'Fluon' is tough, flexible, chemically inert and has a surface to which very few substances will stick.

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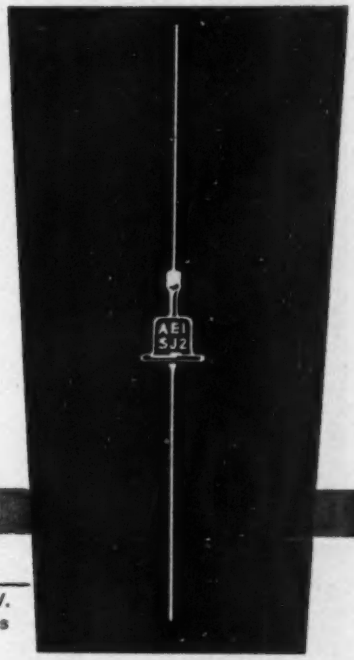

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SJ101F	100	SJ102F	100	SJ101A	100	SJ102A	100
SJ201F	200	SJ202F	200	SJ201A	200	SJ202A	200
SJ301F	300	SJ302F	300	SJ301A	300	SJ302A	300
SJ401F	400	SJ402F	400	SJ401A	400	SJ402A	400
SJ501F	500			SJ501A	500		
SJ601F	600			SJ601A	600		
MAXIMUM JUNCTION TEMPERATURE							
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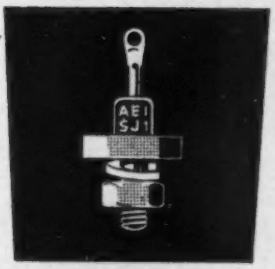

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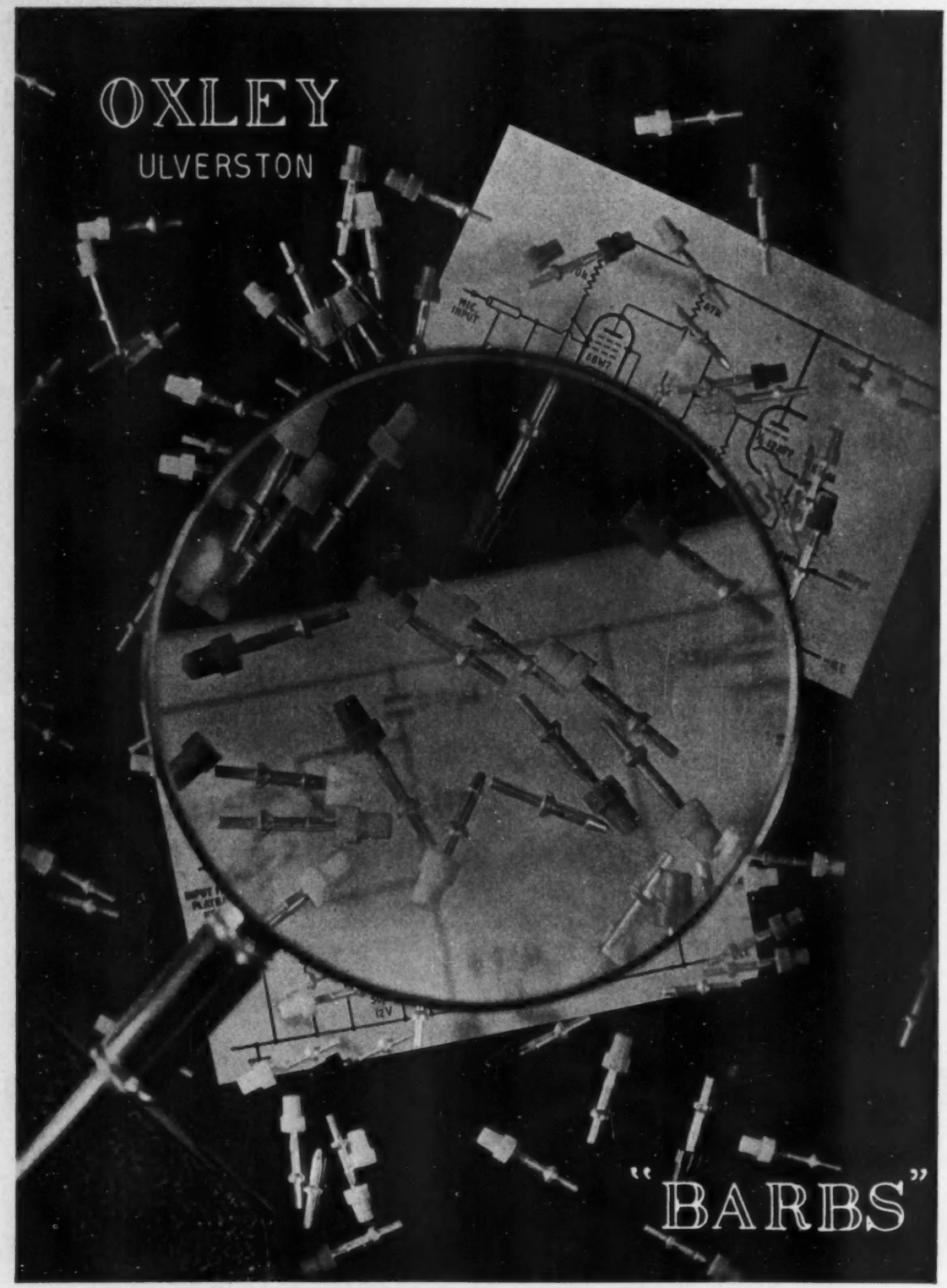

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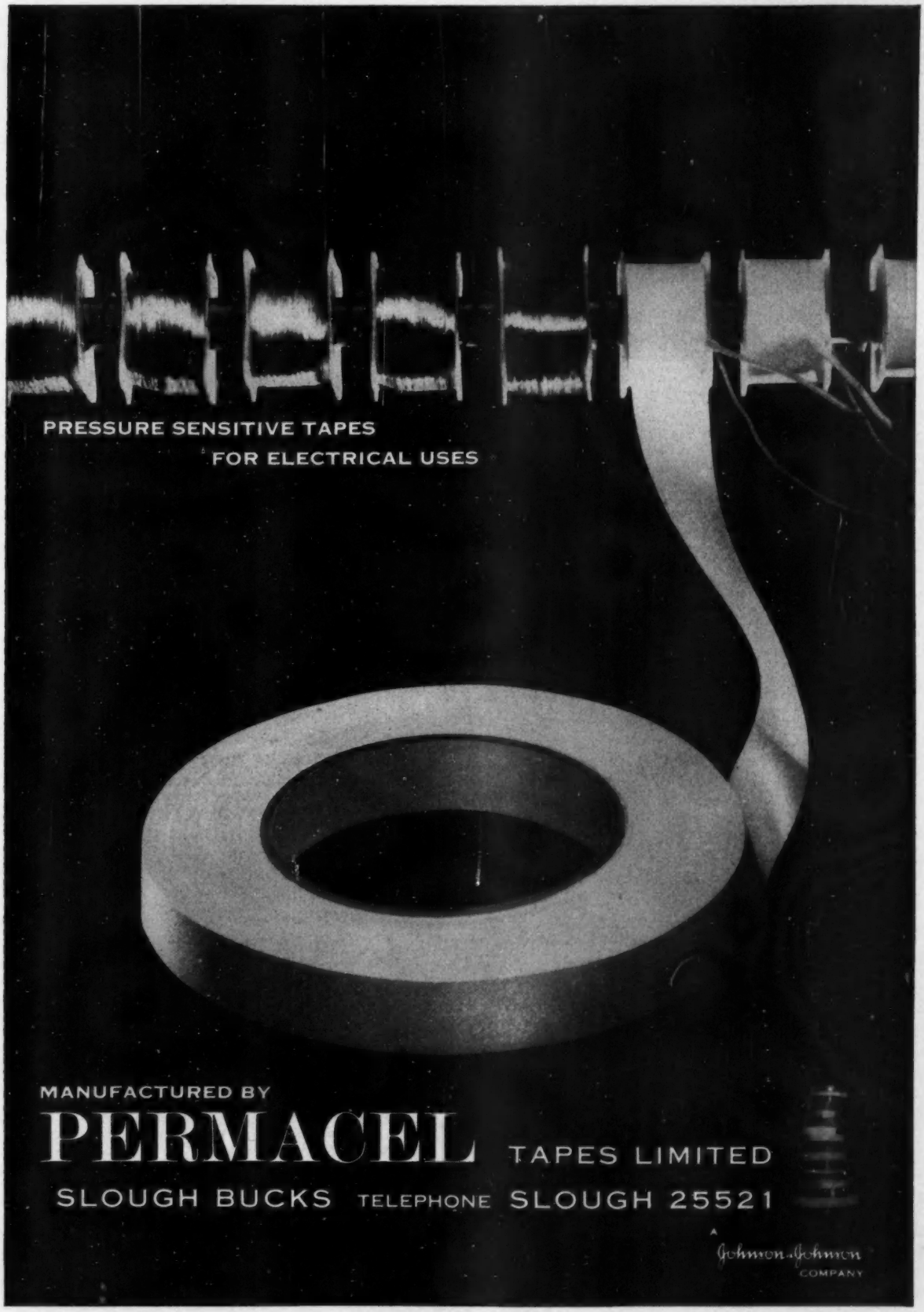

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PYE FOR ELECTRONICS

Cat. No. 8440

Stabilized Power Supply Unit

Outputs: Variable 0 to 500V d.c. (load 250 mA max.), fixed 250V negative d.c. (30 mA), variable 0 to 250V negative d.c. (1 mA). Two separate 6.3V 5A a.c. supplies provided.
Stabilization ± 1% (positive supplies) ± 0.5% (negative supplies). Output resistance less than 0.75 Ω.

Cat. No. 12360

Integrating Amplifier

Completely electronic with no moving parts. Used for gas chromatography, N.M.R. and other applications. Total range 3 to 3000 volt seconds f.s.d. Output either 0—10 mV or 0—1 mA. Exceptional stability and linearity.

Cat. No. 11340/S

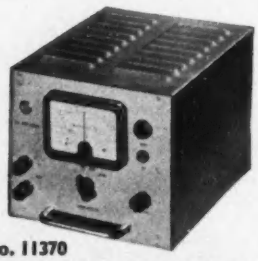
D.C. Amplifier & Microvoltmeter

For the detection and amplification of minute voltages. Ranges ± 10 μV, 100 μV, 1 mV, 10 mV with output 1 mA into 4000 Ω. Input resistance 50Ω. Noise level less than 10^{-13} watt.

Cat. No. 11330

Galvanometer Preamplifier

Gives fast, positive indication on a standard taut-suspension galvanometer for input signals as small as 0.1 μV from a source resistance of about 100Ω.



Cat. No. 11370

D. C. Amplifier (Contact Modulator)

Low voltage amplifier for factory or laboratory. Extremely low drift and noise (≯1μV). Effective suppression of any mains frequency contamination of input signals. High output of ± 10V at currents up to 5 mA. Thoroughly reliable "chopper". Ranges ± 100 μV, 1 mV, 10 mV, 100 mV. Input resistance 3.4 k Ω.

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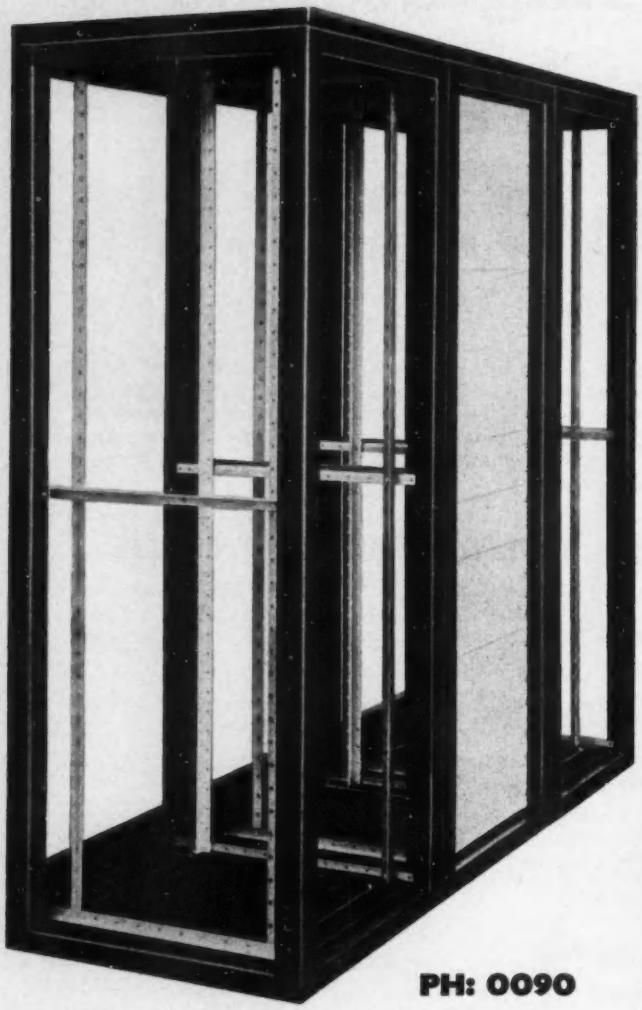

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The quality of every **P & H** cubicle is the product of experience, precision manufacture and rigid inspection.

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Knock down construction — designed to give an absolute rigid assembly — packs flat — is space saving for storage or shipping — assembly takes only minutes — single or multi-bay, takes standard 19 in. P.O. front panels — fixings 1 B.A. or to requirements — chassis depth is variable up to 24 in. Access for installing or servicing equipment from all four sides — dust proof.

Ventilation: Convection or forced draught.
Finish: Stove enamel, two-tone.
Colour: Maroon, BSS-541. Grey, BSS-697.

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8¾ in. panel height for standard 19 in. panels

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in 1¾ in. stages to 21 in. panel height.

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Prices ex works

PH: 0101

Packs flat — space saving — easily and quickly assembled — ventilated by louvres in case bottom and removable back cover. Chrome plated lifting handles — provision for chassis runners — front panel fixings 1 B.A. or to your requirements.

Finish: Stove enamel.
Colour: Maroon, BSS-541.

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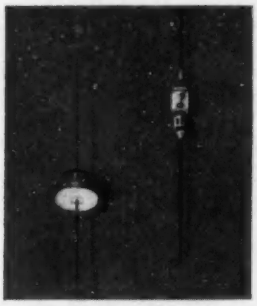

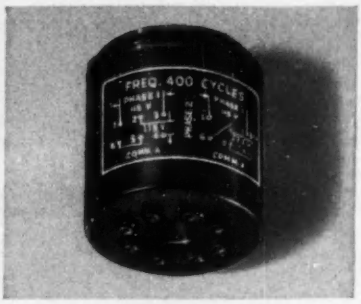

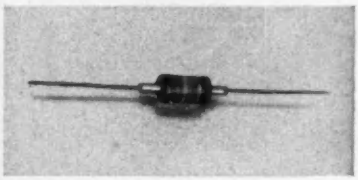

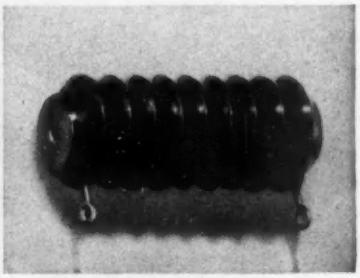

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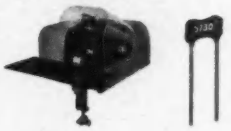
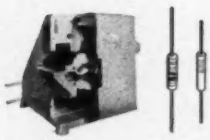
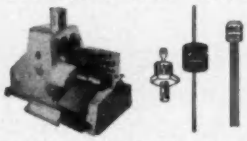


Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 2500 units per hour.

Model 69A — High Speed Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.



Model PAF-AG — Versatility for marking components with axial, one-end axial and radial leads, and components without leads. Production to 3000 per hour. Offset printing unit eliminates rubber plates, and use of Masterplates permits quick changes of all or part of the imprint.



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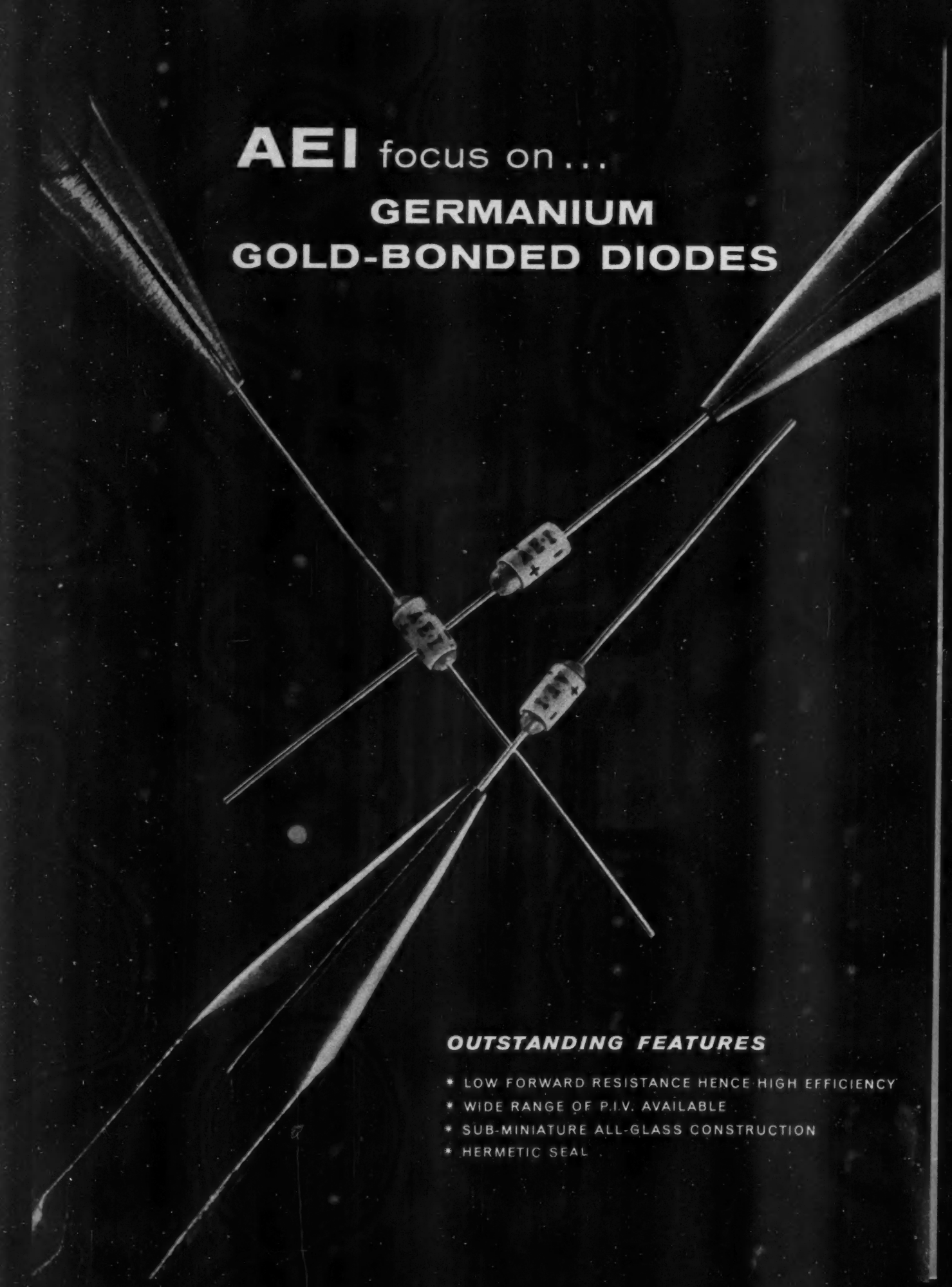

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* SUB-MINIATURE ALL-GLASS CONSTRUCTION
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ADVANCE INFORMATION

FAST GOLD-BONDED DIODE—Type CG84H

Max. Peak Inverse Voltage:	12 volts
Max. Forward Voltage drop at 40 mA, 25°C:	0.6 volts
Max. Inverse Current at -12V, 25°C:	12 microamperes
at -12V, 60°C:	38 microamperes
Max. Mean Forward Current at 25°C:	90 milliamperes
Max. Junction Capacitance at -1V:	2.4 picofarads
Max. Stored Charge at -10V inverse, 10mA forward and 100 ohms circuit impedance:	0.6 milli-micro-coulombs

STANDARD GOLD-BONDED DIODES—
Types CG80H, CG81H, CG82H, CG83H and CG85H

Maximum Ratings

at 25°C ambient temperature	CG80H	CG81H	CG82H	CG83H	CG85H
Peak inverse voltage V	100	75	50	25	12
Mean forward current mA	70	75	77	80	90
Load (averaged over any 20 ms period) mW	100	110	110	110	'14

Forward Characteristics

at 25°C ambient temperature		CG80H to CG83H		
Forward current	mA	10	30	100
Voltage drop. Typical	V	0.375	0.50	0.8
Maximum	V	0.45	0.65	1.1

		CG85H
Forward current	mA	40
Voltage drop. Maximum	V	0.6

Inverse Characteristics		CG80H	CG81H	CG82H	CG83H	CG85H
at P.I.V.	V	100	75	50	25	12
Typical inverse current at 25°C	μA	30	38	20	12	—
at 60°C	μA	150	180	120	75	—
Maximum inverse current at 25°C	μA	100	75	50	25	12
at 60°C	μA	500	300	250	150	38

Capacitance Typical production spreads measured at -1 volt are as follows: Minimum 1.1 pF; Typical 1.8 pF; Maximum 3.0 pF.

Hole Storage When measured with 10 mA forward current, 10 volts inverse voltage and 100 ohms circuit impedance hole storage values are as follows: Typical 1.0 mμC; Maximum 3.0 mμC.

PLEASE DON'T TEAR OUT THIS ADVERTISEMENT— others will want to see it . . . If you would like to receive full details of these or any other AEI electronic components, all you have to do is write to AEI at the address below. Data sheets with detailed information will be sent to you without charge.

HELP YOURSELF *Make sure your name is on our mailing list to receive advance information on all new AEI components.* Don't delay—write NOW!

FEATURES—

common to all types (CG80H to CG85H)

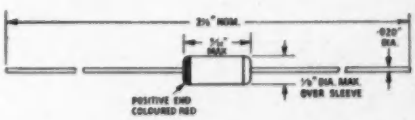
ENCAPSULATION All these AEI Gold-bonded Diodes are of all-glass construction with lead-in wires sealed into the encapsulating tube. The expansion of the wire is matched to that of the glass, providing a hermetic glass-to-metal seal over a wide range of ambient temperatures. The junction is thus fully protected and the characteristics of the diode are very stable because no fluxes, varnishes or other harmful internal contaminants are used.

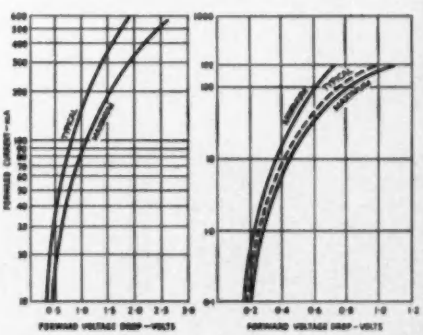
SHOCK-RESISTANCE Because of their small size (about ¼ in. diameter and ¼ in. long), and the rigidity of the small component assemblies, these diodes are able to withstand severe mechanical vibration and shock.

SILVER-PLATED LEADS The lead-in wires are silver-plated to facilitate soldering, but a thermal shunt should be used if heat is applied close to the diode body. In any case, joints should not be made closer than ¼ in. to the diode body and the leads should not be bent closer than 1/16 in.

IDENTIFICATION Normally each type of diode is identified by a plastic sleeve and the polarity is shown by marking the cathode end of the body red.

DIMENSIONS—Similar for all types.





Forward characteristic CG80H to CG83H

Forward characteristic CG84H to CG85H

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And they are ideal for printed circuits, for they can be cemented to the circuit board — a big advantage when acceleration forces are high.

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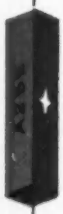
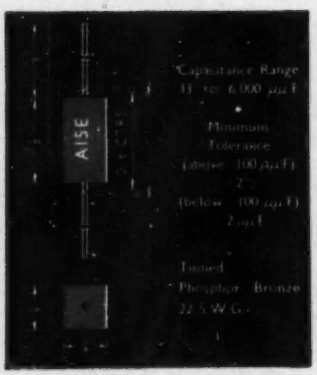
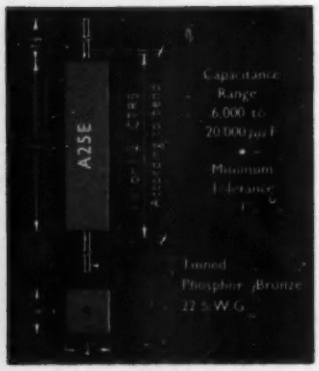
- **Square section**
- **Miniature size**
- **Ideal for printed circuitry**
- **50 volt rating**
- **Fired construction for maximum long-term stability**
- **Synthetic resin encapsulated**
- **Ideal for "high g" applications**
- **Silver Star ® quality**







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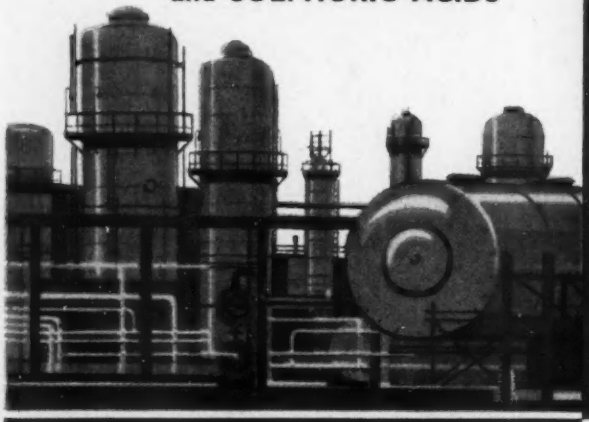

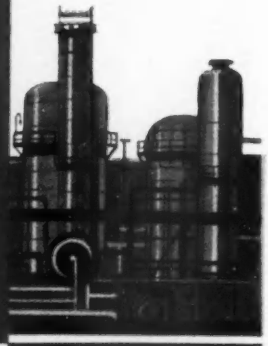

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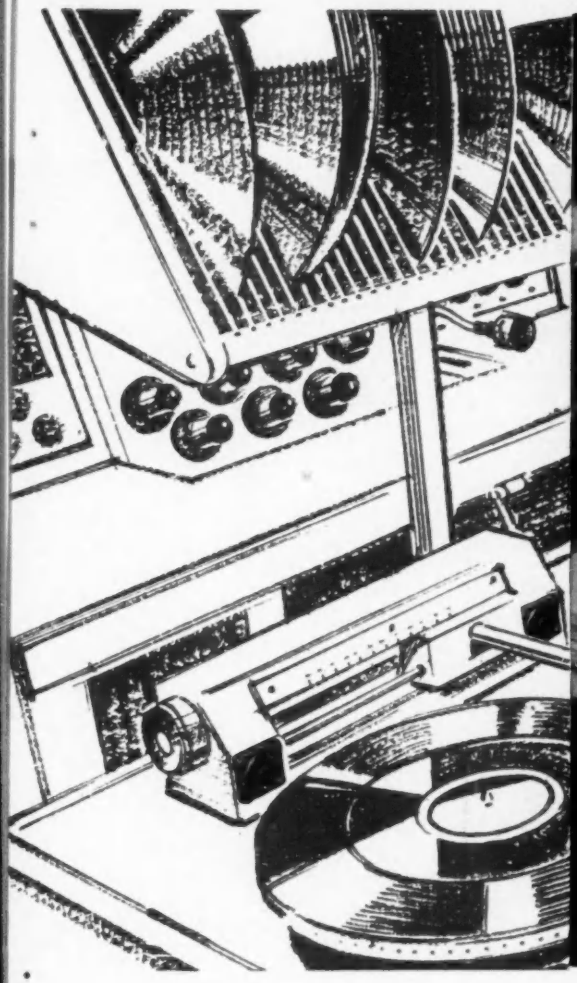

quietly doing a job

The photograph above shows a gramophone turntable bank in the Sound Control Room at the B.B.C. Television Studios, Lime Grove.

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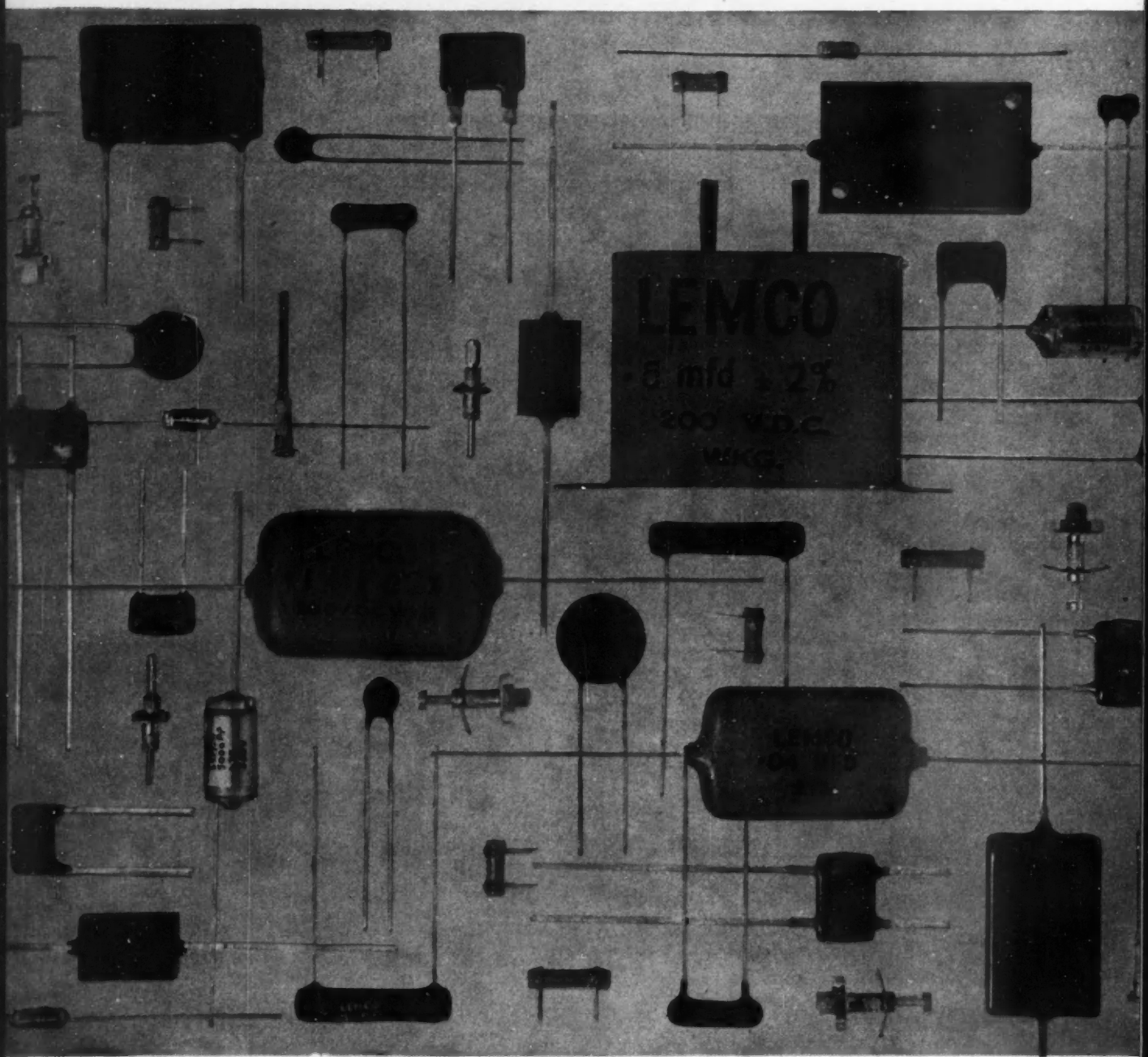

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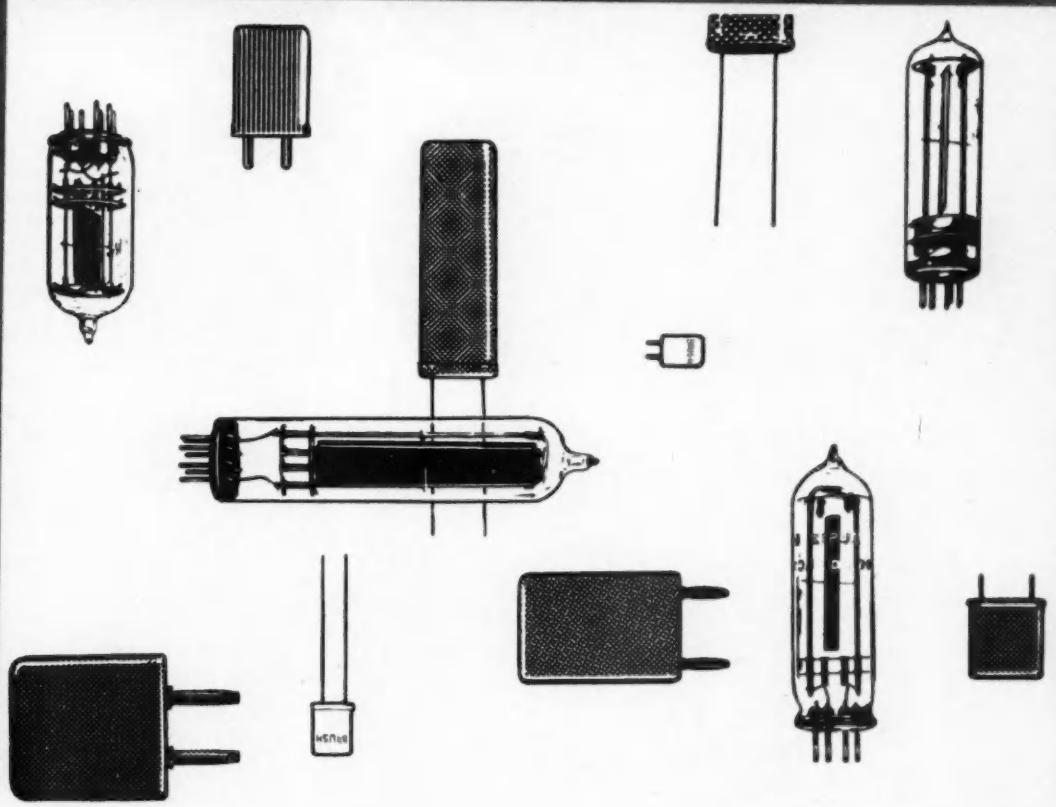

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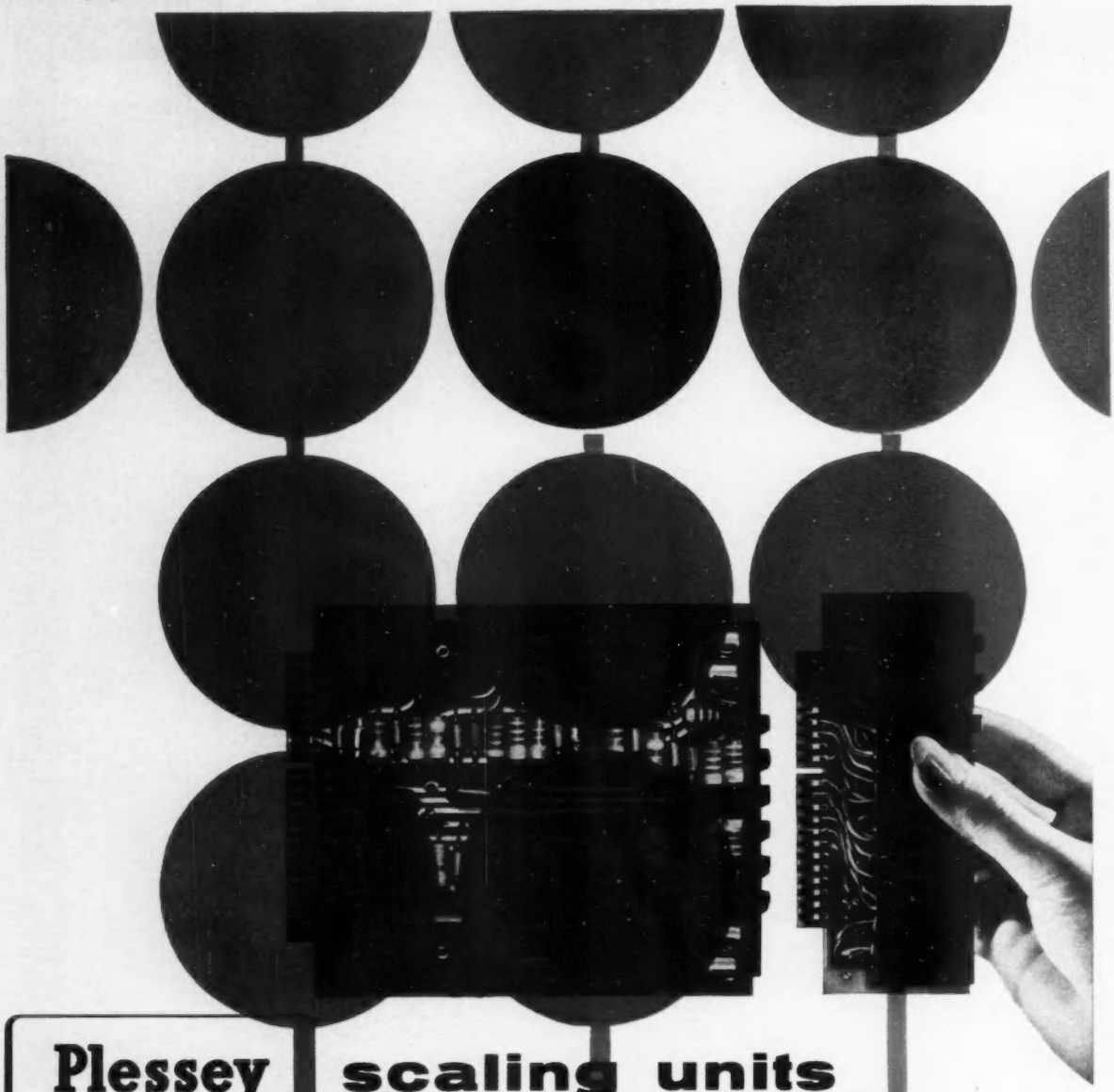

Plessey scaling units

for counting and computing

Plessey Nucleonics are now manufacturing two types of Scaling Unit—a **Decade Scaler** and a **Binary Scaler.** Both are of small overall dimensions and are engineered on plug-in printed circuit boards for general-purpose applications.

The **Decade Scaler** (AERE Type 1003A) has a resolution time of less than 1.5 microseconds and a maximum scaling frequency in excess of 250 kc/s. It provides a 2 microsecond pulse at up to 100 mA and can be stepped by either positive- or negative-going pulses of 0.5 to 1 microsecond width.

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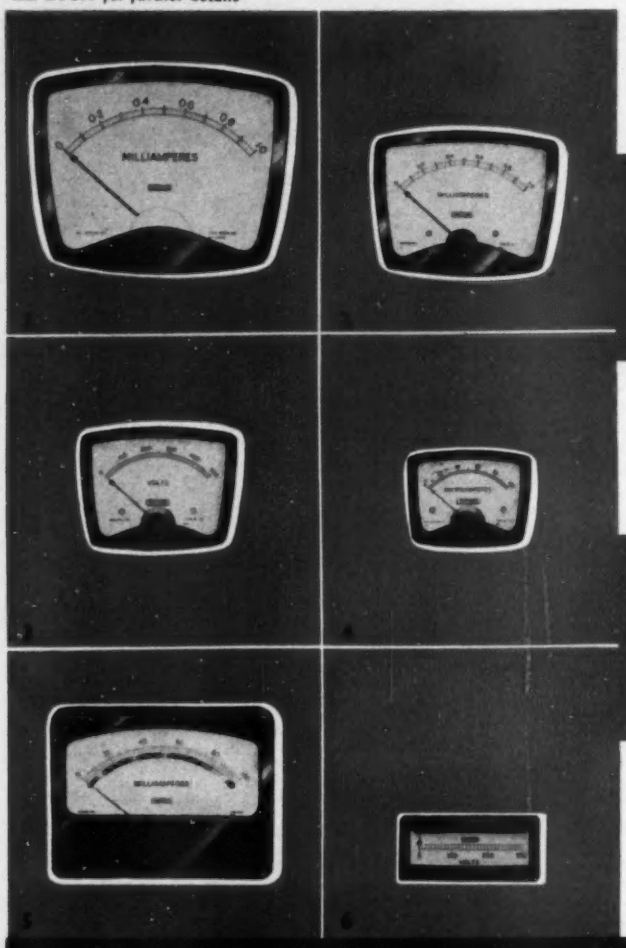

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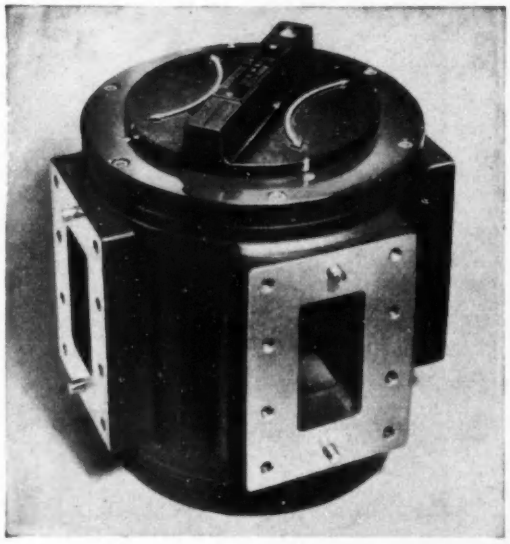

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		At 55°C	At 100°C	At 55°C	At 100°C	At 55°C Volts	
1N2373	600	250	100	10	100	1.0	−55 to +150°C
1N2374	1000	250	100	10	100	2.5	
1N2375	1500	200	100	10	100	3.5	
1N2376	2000	200	100	10	100	6.0	
1N2379	4000	100	50	10	100	12.0	
1N2380	6000	100	50	10	100	18.0	
1N2381	10000	75	25	10	100	30.0	
1N2381A	12500	75	25	10	100	30.0	

1N 1130
1N 1131

1N 2373
to
1N 2381A

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IC5	5000	75	50†	20	300	15.0	0 to +100°C
IC10	10000	60	40†	20	300	30.0	
1N1130*	1500	300	230	50	150	3.5	−55 to +150°C
1N1131*	1500	300	230	50	150	3.5	

Ratings given for Resistive or Inductive loads
* On 2" x 2" x 1/16" Aluminium fin.
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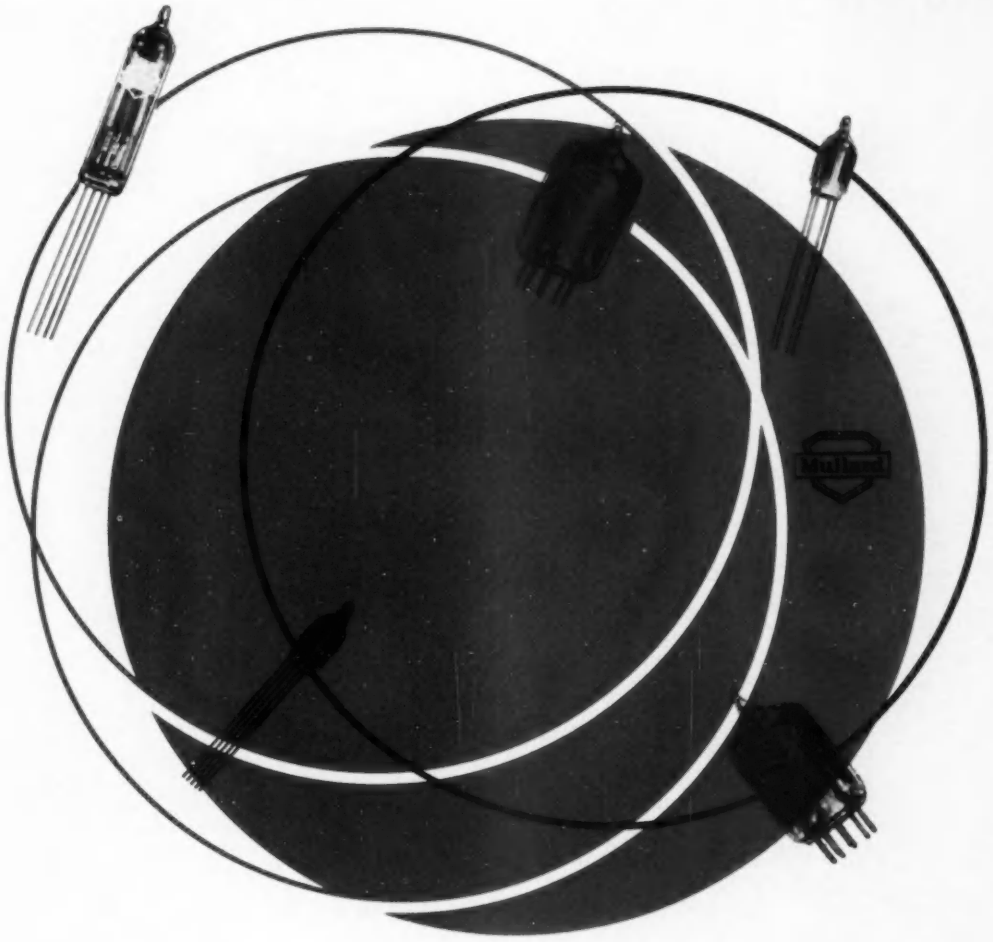

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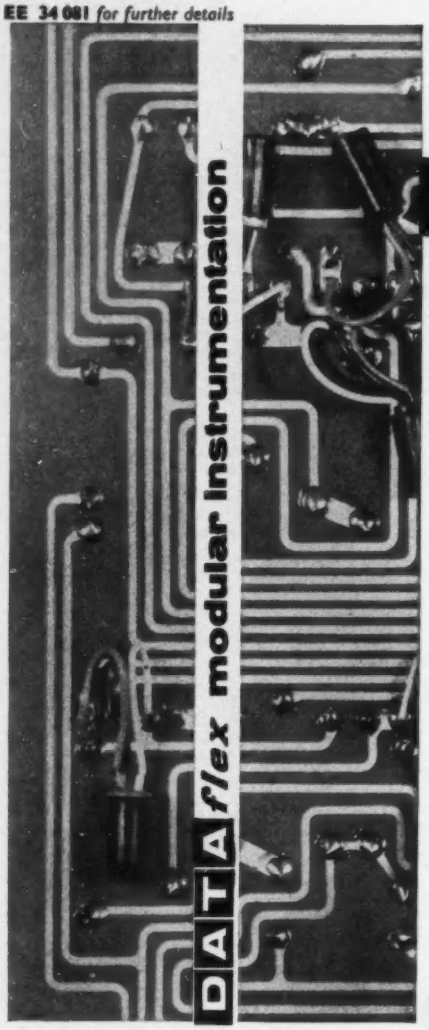

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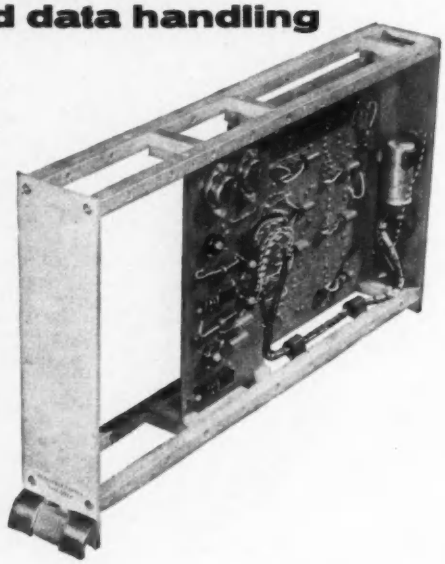

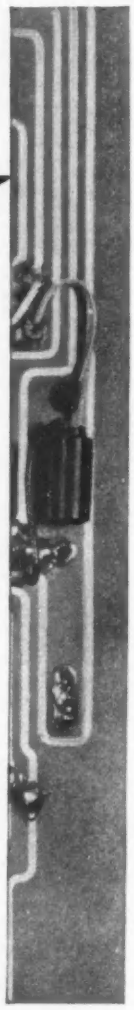

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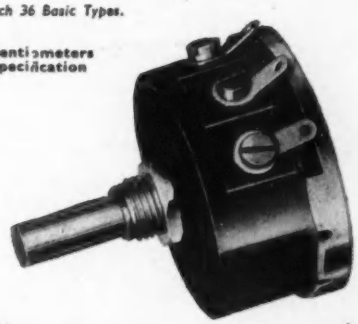

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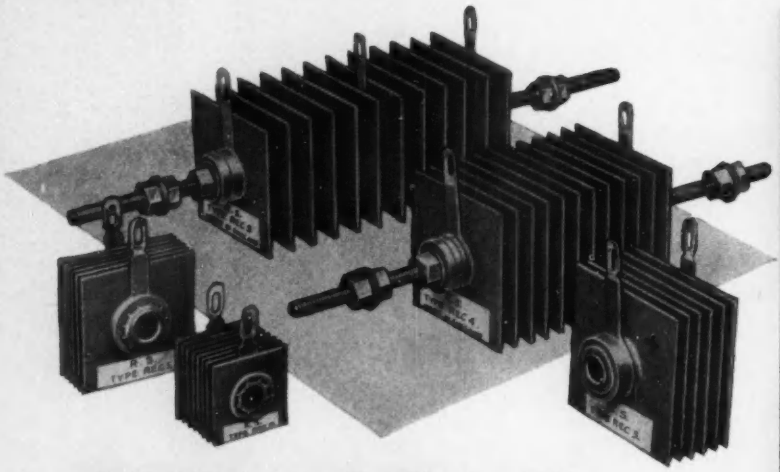

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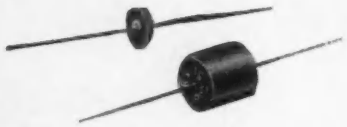

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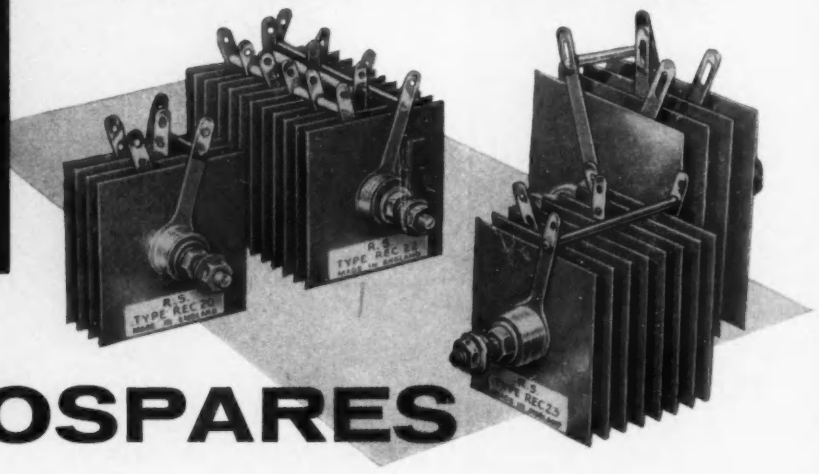

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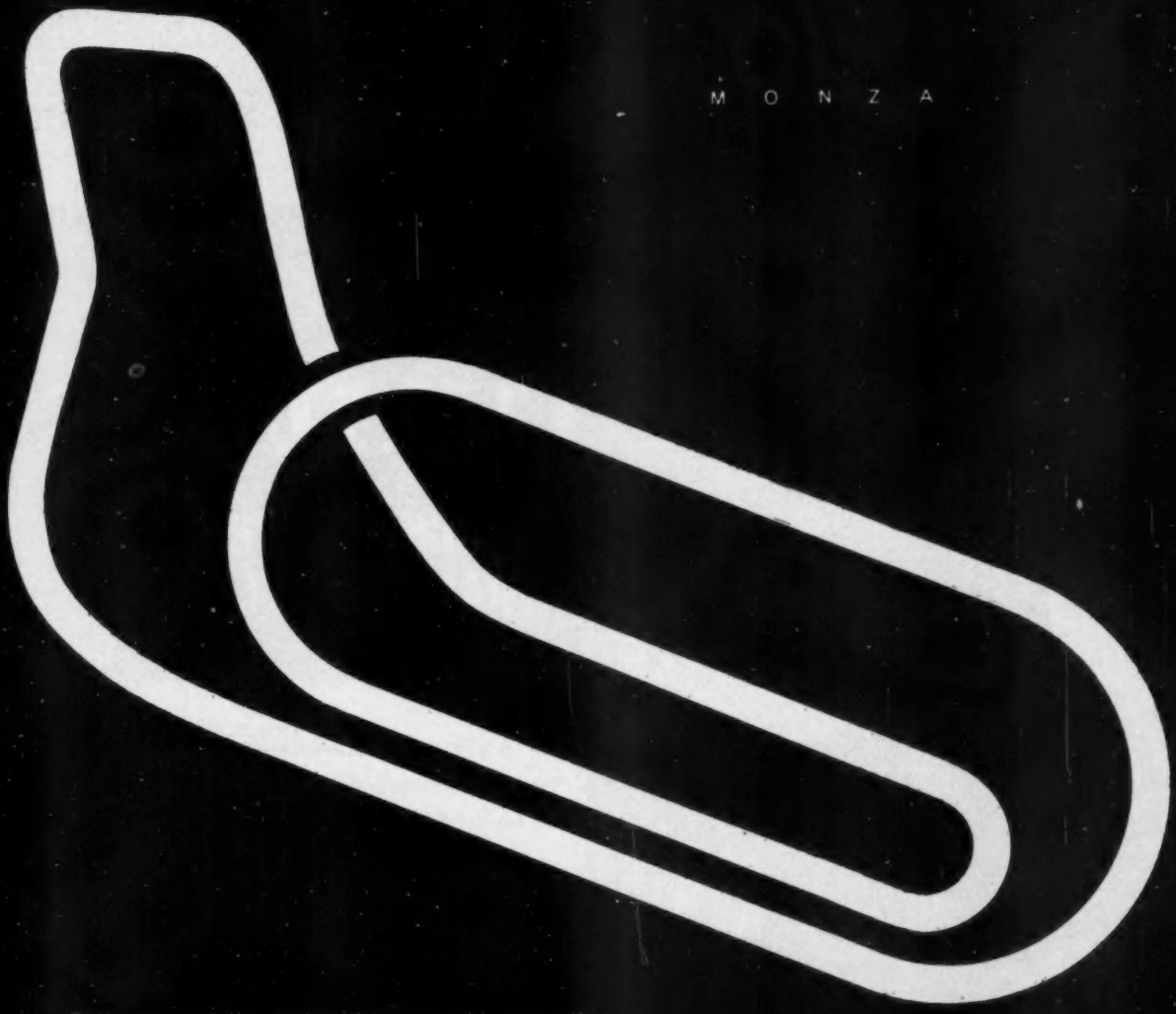

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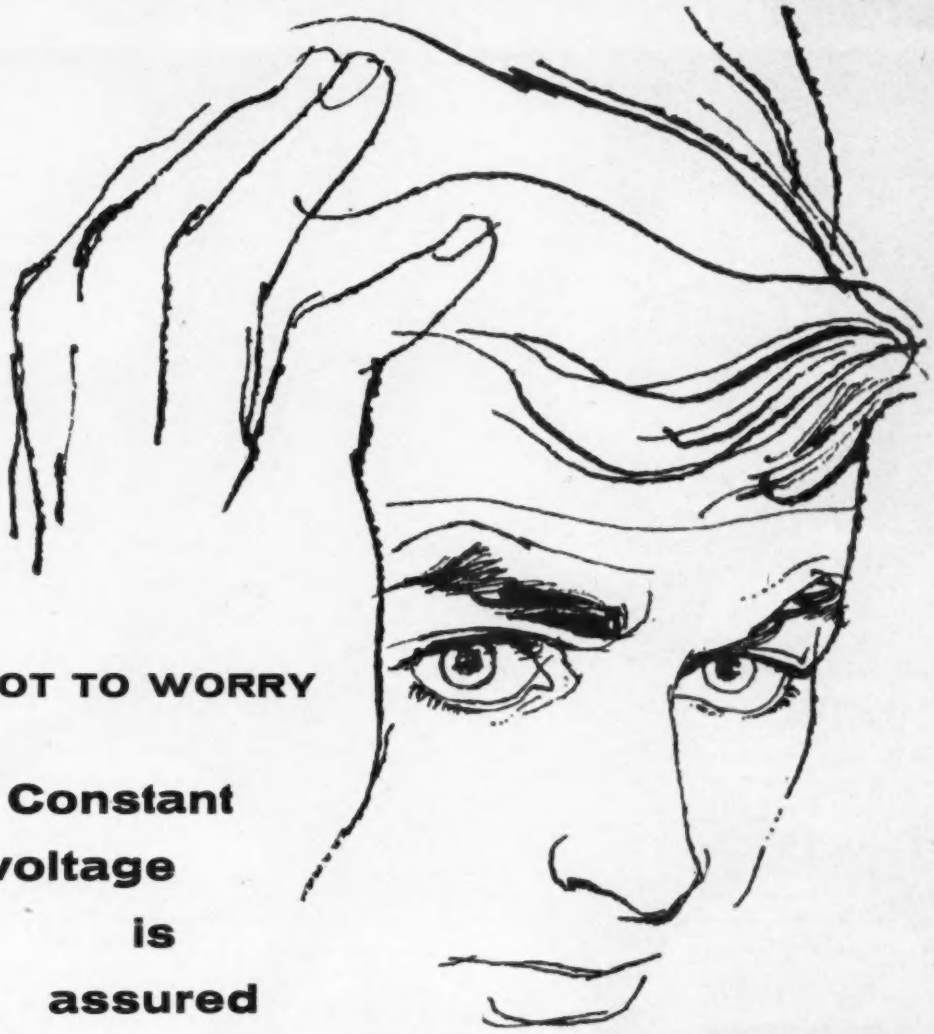

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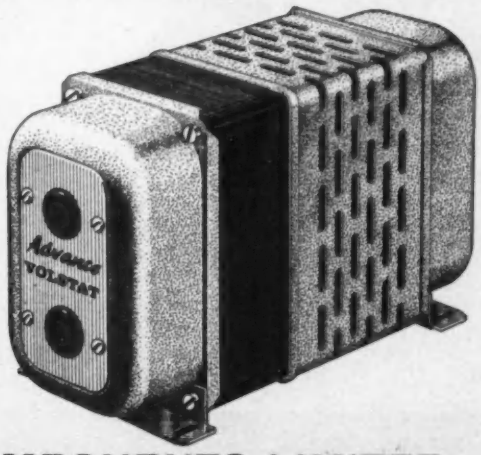

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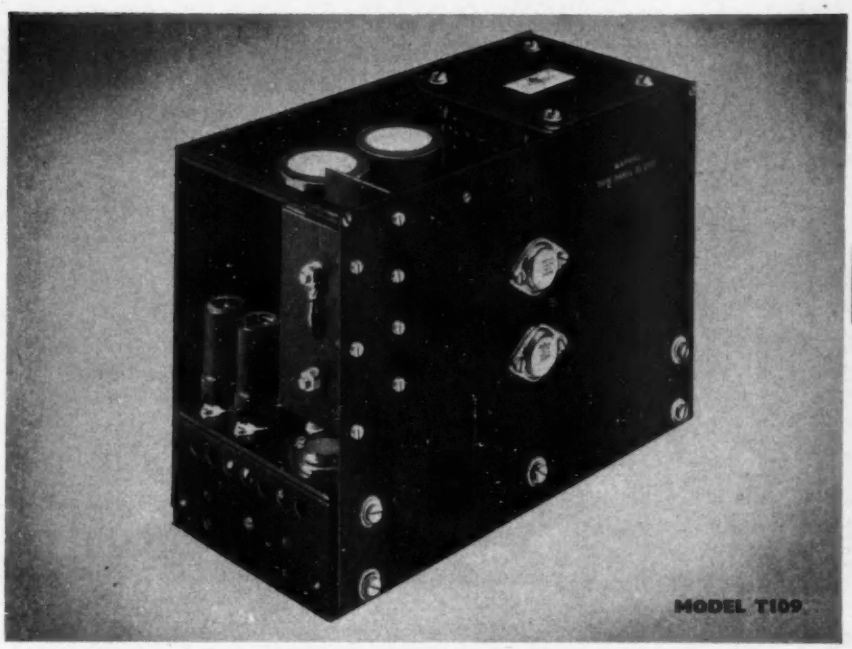

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T108	50 max.	1·0	0·1	0·1	1·0	8½ 5½ 6½	8	55 0 0
T109	50 max.	2·0	0·05	0·1	1·0	10½ 5½ 7½	13	70 0 0
T110	30 max.	5·0	0·01	0·1	1·0	13½ 8½ 7½	23	98 0 0
T114	30 max.	10·0	0·01	0·1	1·0	17 10 8½	39	135 0 0
Please order as follows: Type No./Voltage required. For example: T109/45 is a 45 volt 2A unit.								
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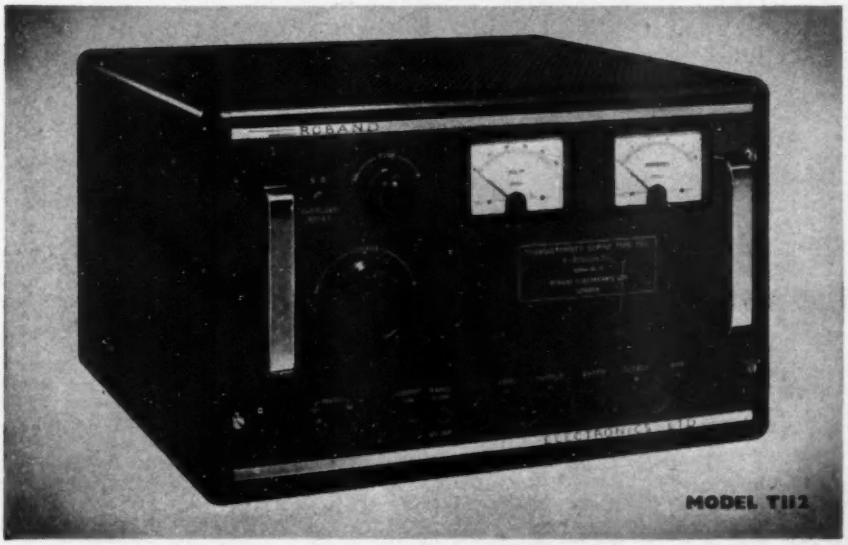
T102	0–30	2·0	0·05	0·1	1·0	16⅝ 10½ 10½	30	100 0 0
T103	0–30	1·0	0·05	0·1	1·0	13½ 10½ 9½	19½	85 0 0
†T104	0–30 / 0–30	1·0 / 1·0	0·05 / 0·05	0·1 / 0·1	1·0 / 1·0	16⅝ 10½ 10½	30	129 0 0
T105	0–50	2·0	0·05	0·1	1·0	16⅝ 10½ 10½	30	118 0 0
T106	0–100	1·0	0·1	0·1	2·0	*21½ 14½ 11½	46	149 0 0
T107	0–100	2·0	0·1	0·1	2·0	*21½ 14½ 11½	60	183 0 0
T111	0–50	5·0	0·01	0·1	2·0	*21½ 18½ 11½	64	155 0 0
T112	0–50	10·0	0·01	0·1	2·0	*21½ 20½ 13½	101	245 0 0
T113	0–30	20·0	0·01	0·1	2·0	*21½ 21 16½	139	315 0 0

*Panel and chassis withdrawable to fit 19" rack. †Note that T104 has two independent floating sections.



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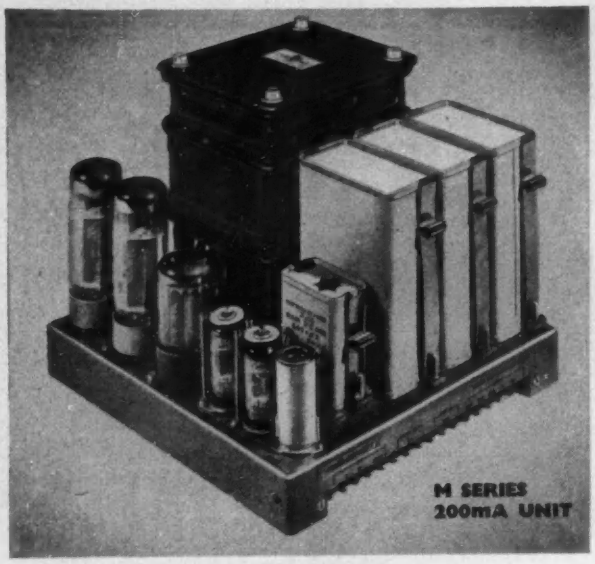

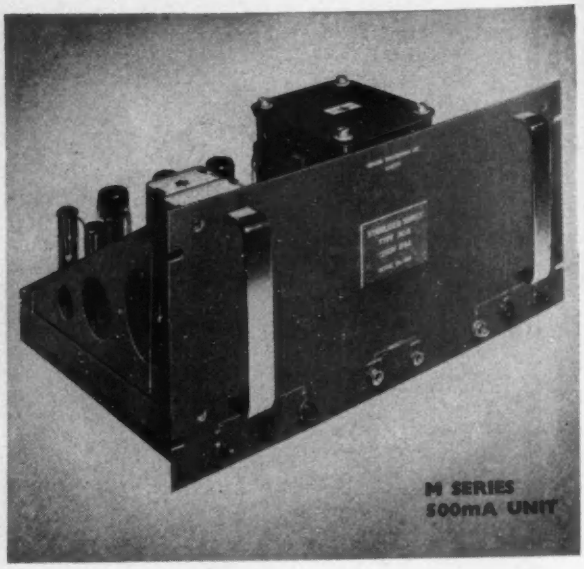

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M SERIES OPEN CHASSIS UNITS (Mains 200/250V A.C. 115V models also available)									
M22	150	0–20	Nil	0·1	0·02	1·0	4½ 3½ 4⅜	2½	26 0 0
M22A	200	0–20	Nil	0·1	0·02	1·0	4½ 3½ 4⅜	2½	26 0 0
M23	150	0–50	2 & 1	0·1	0·02	1·0	6 5½ 5½	6	27 10 0
M23A	200	0–50	2 & 1	0·1	0·02	1·0	6 5½ 5½	6	27 10 0
M33	250	0–50	2 & 1	0·1	0·02	1·0	6 5½ 5½	6	27 10 0
M33A	300	0–50	2 & 1	0·1	0·02	1·0	6 5½ 5½	6	27 10 0
M14A	100	0–100	3 & 3	1·0	0·02	1·0	10⅜ 7 6½	14½	63 0 0
M24	150	0–100	3 & 3	0·1	0·02	1·0	7½ 6½ 6½	12½	33 10 0
M24A	200	0–100	3 & 3	0·1	0·02	1·0	7⅛ 6½ 6½	12½	33 10 0
M34	250	0–100	3 & 3	0·1	0·02	1·0	7⅛ 6½ 6½	12½	33 10 0
M34A	300	0–100	3 & 3	0·1	0·02	1·0	7⅛ 6½ 6½	12½	33 10 0
M25	150	0–200	3 & 3	0·1	0·02	1·0	8½ 8½ 7	20	52 10 0
M25A	200	0–200	3 & 3	0·1	0·02	1·0	8½ 8½ 7	20	52 10 0
M35	250	0–200	3 & 3	0·1	0·02	1·0	8½ 8½ 7	20	52 10 0
M35A	300	0–200	3 & 3	0·1	0·02	1·0	8½ 8½ 7	20	52 10 0
M26S	150	30–500	5 & 5	0·1	0·02	1·0	14 11½ 8	20	88 0 0
M26SA	200	0–500	5 & 5	0·1	0·02	1·0	14 11½ 8	35½	88 0 0
M36S	250	0–500	5 & 5	0·1	0·02	1·0	14 11½ 8	35½	88 0 0
M36SA	300	0–500	5 & 5	0·1	0·02	1·0	14 11½ 8	35½	88 0 0
M28	150	30–350	5 & 5	0·1	0·02	1·0	13½ 8½ 6⅞	29	66 0 0
M28A	200	0–350	5 & 5	0·1	0·02	1·0	13½ 8½ 6⅞	29	66 0 0
M38	250	0–350	5 & 5	0·1	0·02	1·0	13½ 8½ 6⅞	29	66 0 0
M38A	300	0–350	5 & 5	0·1	0·02	1·0	13½ 8½ 6⅞	29	66 0 0
M SERIES FRONT PANEL UNITS (Mains 200/250V A.C. 115V models also available)									
M26	150	30–500	5 & 5	0·1	0·02	1·0	19 12 8½	46½	97 10 0
M26A	200	0–500	5 & 5	0·1	0·02	1·0	19 12 8½	46½	97 10 0
M36	250	0–500	5 & 5	0·1	0·02	1·0	19 12 8½	46½	97 10 0
M36A	300	0–500	5 & 5	0·1	0·02	1·0	19 12 8½	46½	97 10 0
M27	150	50–1·0A	5 & 5	0·1	0·02	1·0	19 15½ 8½	50½	165 0 0
M27A	200	0–1·0A	5 & 5	0·1	0·02	1·0	19 15½ 8½	50½	165 0 0
M37	250	0–1·0A	5 & 5	0·1	0·02	1·0	19 15½ 8½	50½	165 0 0
M37A	300	0–1·0A	5 & 5	0·1	0·02	1·0	19 15½ 8½	50½	165 0 0
M29	150	100–2·0A	5 & 5	0·1	0·C2	1·0	19 18 10½	82½	255 0 0
M29A	200	0–2·0A	5 & 5	0·1	0·02	1·0	19 18 10½	82½	255 0 0
M39	250	0–2·0A	5 & 5	0·1	0·02	1·0	19 18 10½	82½	255 0 0
M39A	300	0–2·0A	5 & 5	0·1	0·02	1·0	19 18 10½	82½	255 0 0

(All C.T.)

B SERIES

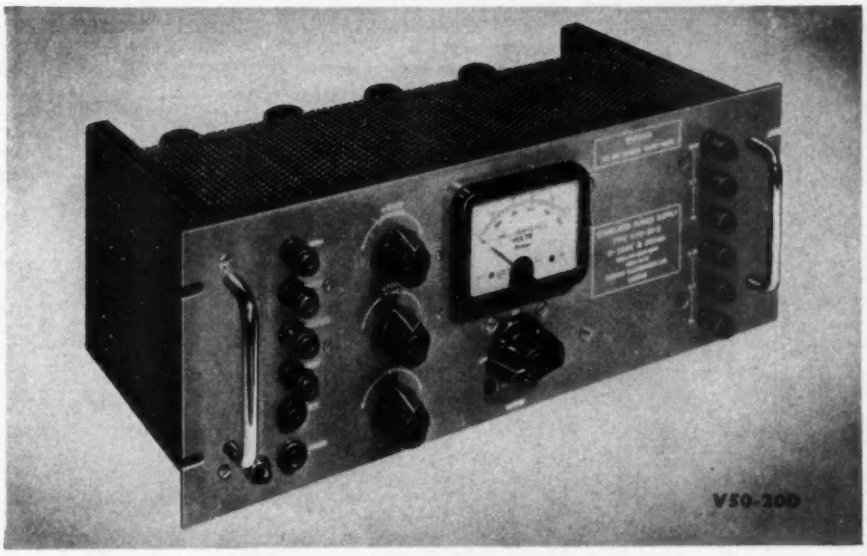
Rugged reliable units

Probably the most advanced series of open chassis units available today and characterised by an extremely rugged construction and a line-up of inter-services approved reliable valves. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) and a mains selector panel is included.

A compact welded rectangular framework of extruded angle aluminium alloy rigidly secures the 'C' core transformer and the 14 S.W.G. chassis housing the electronic sub-assembly. Because all the vulnerable components are located within the framework the risk of accidental damage is greatly minimised.

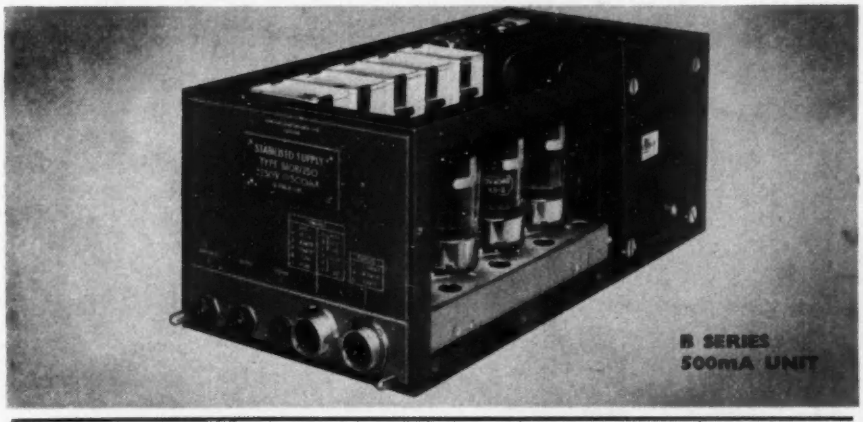
The framework contains anchor nuts which facilitate mounting the units in a variety of ways. It is permissible, for instance to secure any two units side by side to a standard 19" x 7" front panel.

High efficiency silicon junction rectifiers, series valves operating as pentodes and a 'C' core transformer to H2 specification ensure a minimum temperature rise within the unit. Insulated carbon and vitreous wire-wound resistors are used throughout and the conservative design permits continuous operation at full load even when the mains are permanently ±10% from nominal.



POWER SUPPLIES

ROBAND



MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L X D X HT.	WEIGHT IN LBS.	EX-WORKS £ S. D.
B SERIES RUGGED RELIABLE UNITS (Mains 200-250V A.C. & 100-125V A.C.)									
B101/150	150	30–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/200	200	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/250	250	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/300	300	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/350	350	0–100	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B102/150	150	30–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/200	200	0–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/250	250	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/300	300	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/350	350	0–200	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B103/150	150	30–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/200	200	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/250	250	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/300	300	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/350	350	0–400	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0

— ALL C.T. —

M SERIES

Open chassis units

Since their introduction some years ago, these chokeless supplies have firmly established their superiority over more conventional circuits. Their smaller size—excellent high frequency performance and stable operation down to at least 1 c.p.s.—reliability at elevated temperatures and safe operation for ±10% mains changes—coupled with the highest engineering standards confirm the "M" Series as the first choice in stabilised units.

Front panel units

The front panel units have been designed for use with standard 19" racks. The panel is finished in B.S.S.632 grey (or any other colour at no extra cost) and houses the handles, mains and H.T. switches, fuses and indicator lamps. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) at the rear of the chassis.

V SERIES Regulated variable voltage units

A range of regulated variable voltage supplies for use on the bench or standard 19" racks. Minimum weight and low internal heat dissipation are obtained by using chokeless circuits, 'C' core transformers, silicon junction rectifiers and series valves operating as pentodes.

V50-50. An exceptionally stable decade controlled 0 to 500V 500mA unit. A fixed 250V 50mA negative rail and two 6.3V 5A centre tapped windings are included.

The decade system enables the output to be changed incrementally with a much greater accuracy than that obtained by normal methods.

Price £137-10-0 ex-works

V50-20D. A 0 to 500V 200mA unit (restricted to 150mA below 200V) of moderate performance. A regulated variable negative rail from 0 to 85V via a 100K potentiometer and two 6.3V5A centre tapped windings are included. A coarse control varies the output from 0 to 500V in one continuous sweep and a fine control is included.

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2V35-25. A very compact unit containing several regulated output voltages. There are two 0 to 350V 250mA sections (restricted to 150mA below 200V) which may be operated separately, in parallel or in series. Each section has a coarse control to vary the output from 0 to 350V in one sweep and a fine control is included. A fixed 250V 50mA negative rail and two 6.3V5A centre tapped windings are provided.

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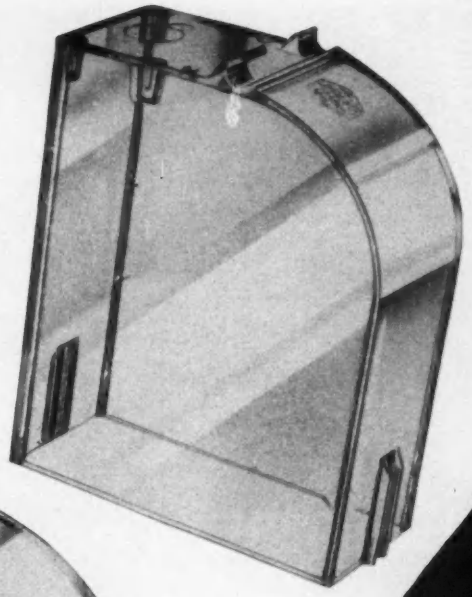

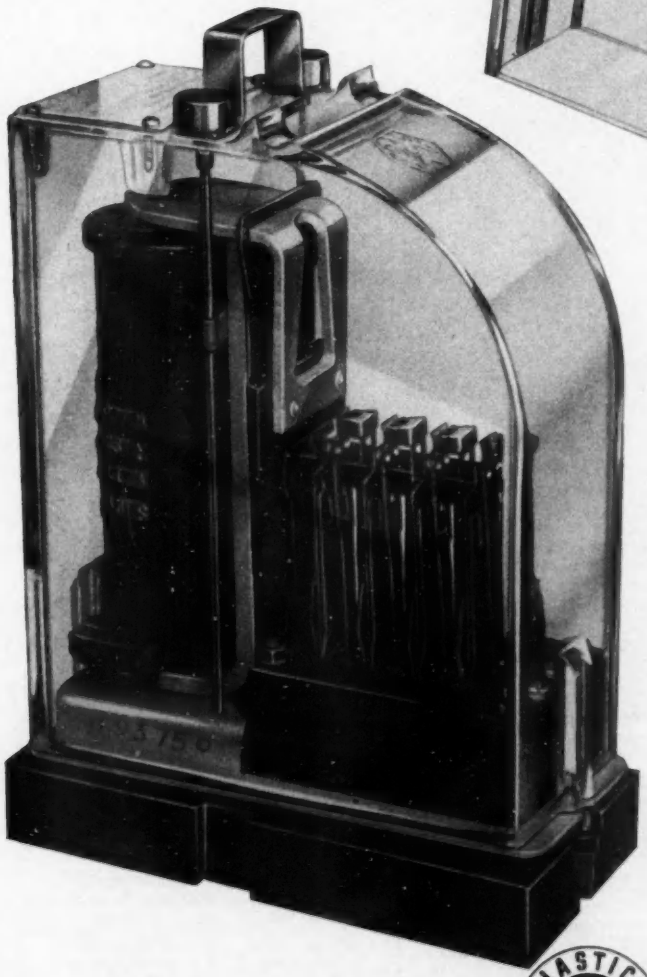

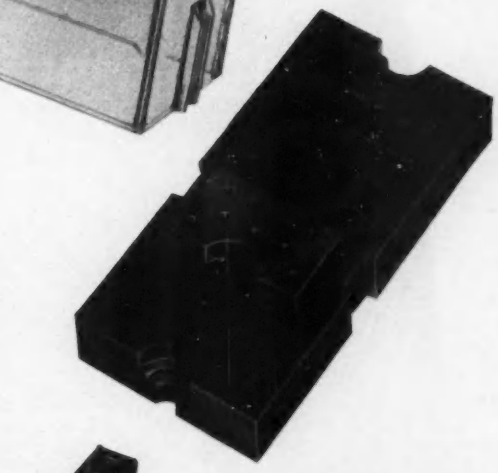

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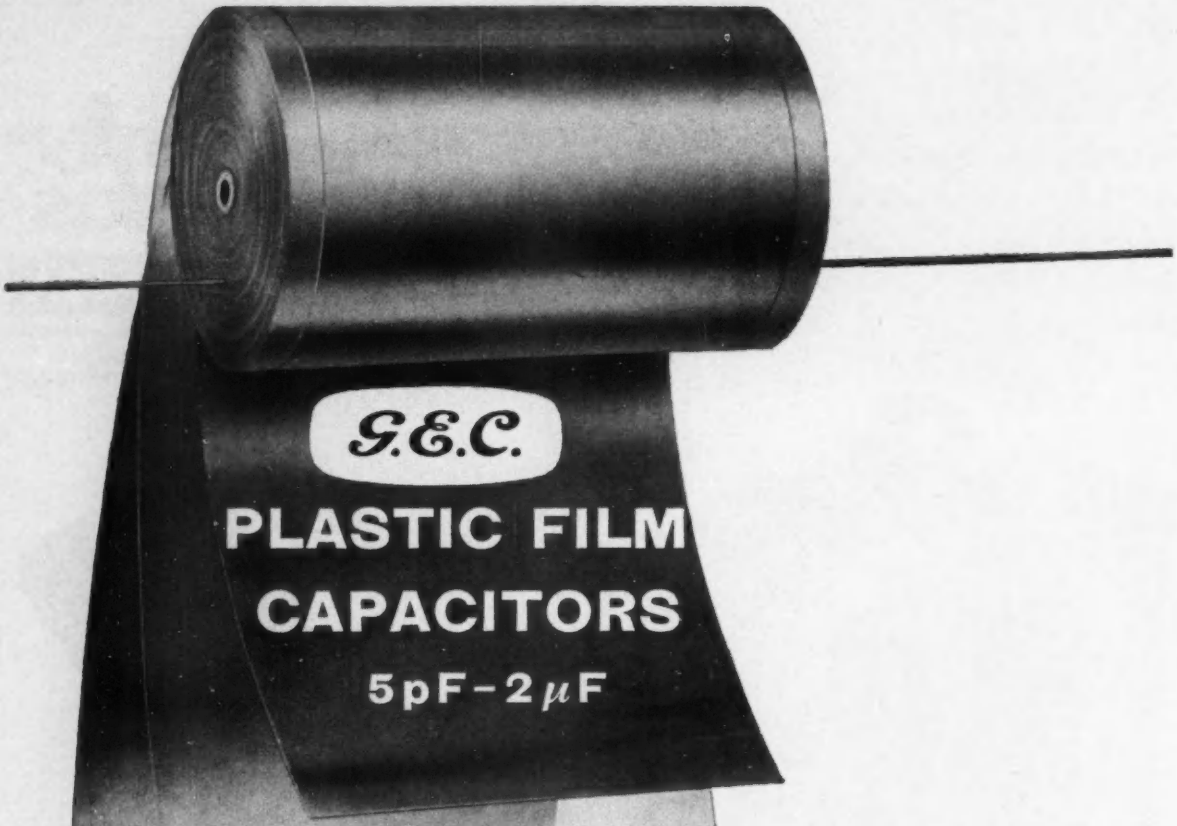

G.E.C.

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These components are pre-eminent in the field of plastic film capacitors. Advanced manufacturing techniques supported by the Company's vast resources for research and development combine to produce a wide range of high-quality capacitors based on either polystyrene or polyester dielectric in a film and foil construction, at reasonable cost. This construction ensures maximum reliability.

The basic characteristics of the capacitors are detailed in the table below:

CHARACTERISTIC	POLYSTYRENE CAPACITORS		POLYESTER CAPACITORS	
	Type PF	Type A597	Type PFT	Type A596
Overall Range	5pF–510,000pF	150pF–510,000pF	0·001μF–2μF	0·05μF–2μF
Working Voltages	125–2,000 V.D.C. 750–2,000 V.A.C.	125 V.D.C. 350 V.D.C. 750 V.D.C. 2,000 V.D.C.	150 V.D.C. 250 V.D.C. 350 V.D.C. 500 V D.C.	150 V.D.C.
Insulance or Insulation resistance	10^6M Ω.	10^4M Ω.	20,000M Ω. /μF or 50,000M Ω. whichever is the less	20,000M Ω. /μF or 50,000M Ω. whichever is the less
Working Temperature Range	−40°C to +70°C derate stability at +70°C to +85°C	−40°C to +70°C	−40°C to +100°C derate voltage at +85°C	−40°C to +100°C derate voltage at +85°C
Power Factor	≤·0005	≤·0005	≤·007	≤·007
Temperature Coefficient	120×10⁻⁶ per °C nom.	−130±15×10⁻⁶ per °C	+200×10⁻⁶ per °C nom.	+200×10⁻⁶ per °C nom.
Capacitance Stability Temperate	≈0·25%	≈0·05%	≈0·5%	<0·5%
Capacitance Stability Tropical	†	*	<5% after H2	5%*
Test Voltage	3× wkg.	3× wkg.	2× wkg.	2× wkg.

*Rated RCS11 H1 †Requires sealing for tropical conditions

For further information please write to:

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Smee's GEC 84

The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analogue tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds – 1⅞, 3¾, 7½, 15, 30 and 60 ips – and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from −50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

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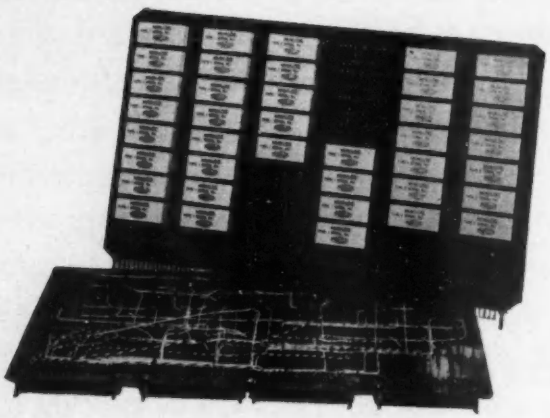

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No thermostat
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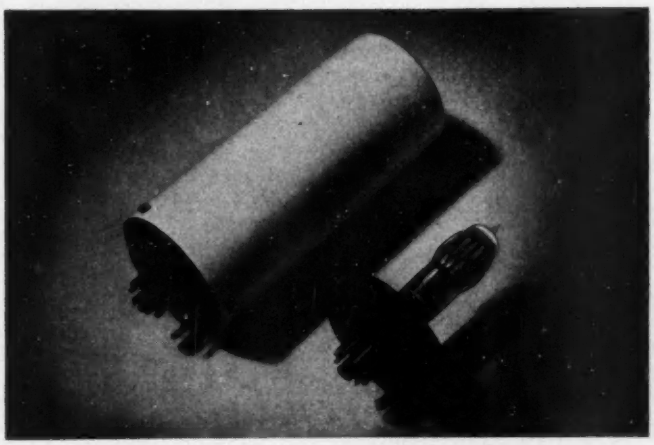

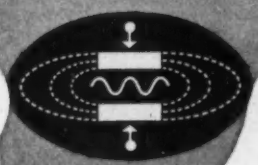

This symbol has been adopted by the Marconi Specialized Components Group. The Marconi Company undertakes the design and manufacture of specialized components only when no suitable alternative is available; and in almost every case, Marconi specialized components are designed to more exacting standards and built to closer tolerances than any similar components. A preliminary catalogue is available, listing ferrite isolators and circulators, coaxial connectors, attenuators, terminations and switches; waveguide filters terminations, and bends; crystal filters and ovens.

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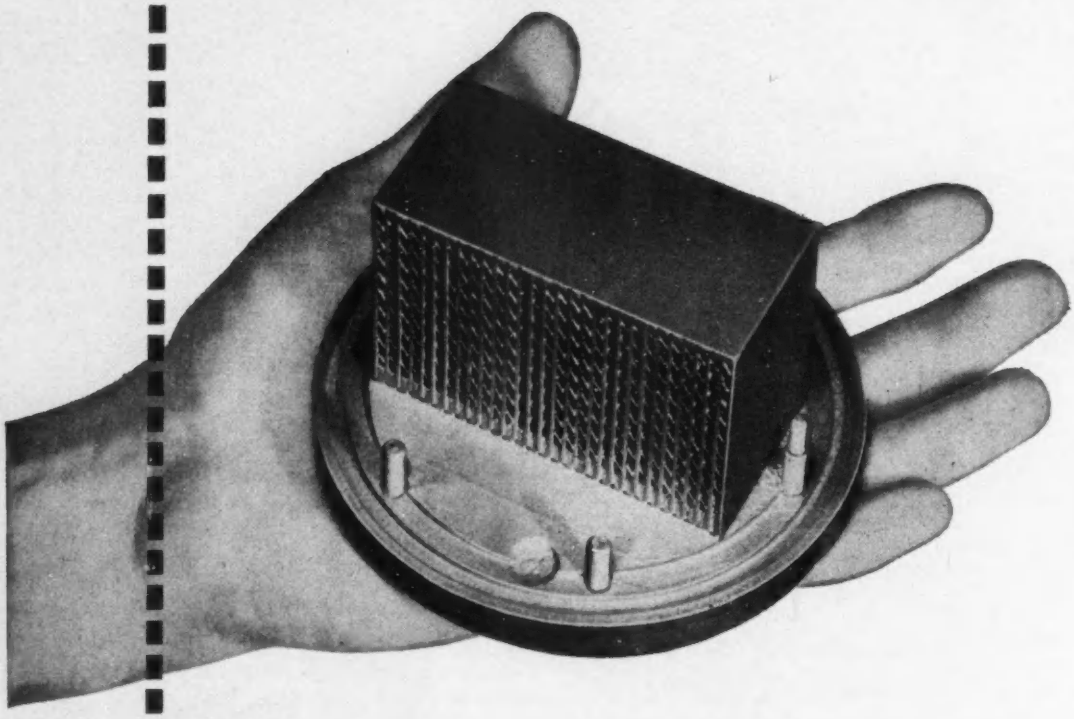

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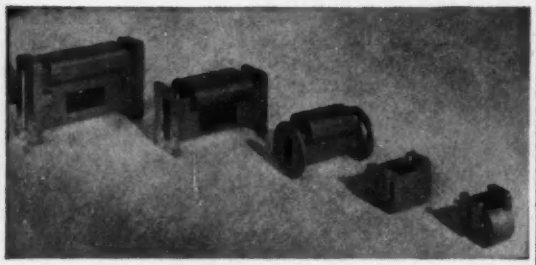

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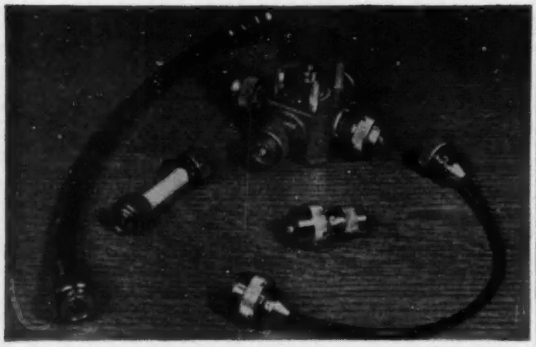
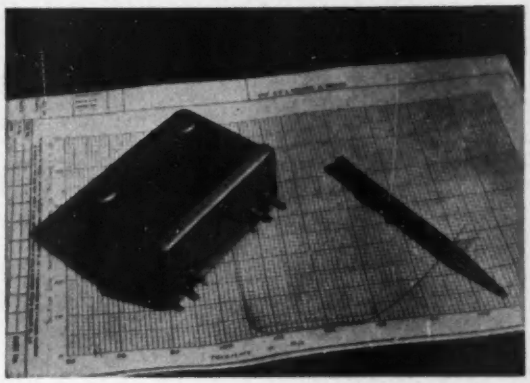


Designed to combine low VSWR with positive mechanical connection at 5000 mc/s, this connector is unique in its use for laboratory measurements and for any application calling for a stable and reliable match. Alternative arrangements are available for flexible cables or panel mounting use. The connectors are normally female but can be converted to male by the simple addition of a locating ring and connecting pin. The design incorporates a sealing ring for waterproofing the connecting joint.

Miniature Crystal Filters



Crystal filters operating at 100 kc/s with bandpass characteristics.
Pairs of upper and lower sideband selection filters for SSB applications.
IF filters at 455 kc/s.
Marconi's are constantly engaged in the development of new crystal filter techniques, and it is impossible to specify the large number of filter designs available. The Company's unique experience in this field enables us to offer advice and technical assistance with filter problems of any kind.

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A preliminary catalogue is available listing specialized components for immediate delivery.

W3

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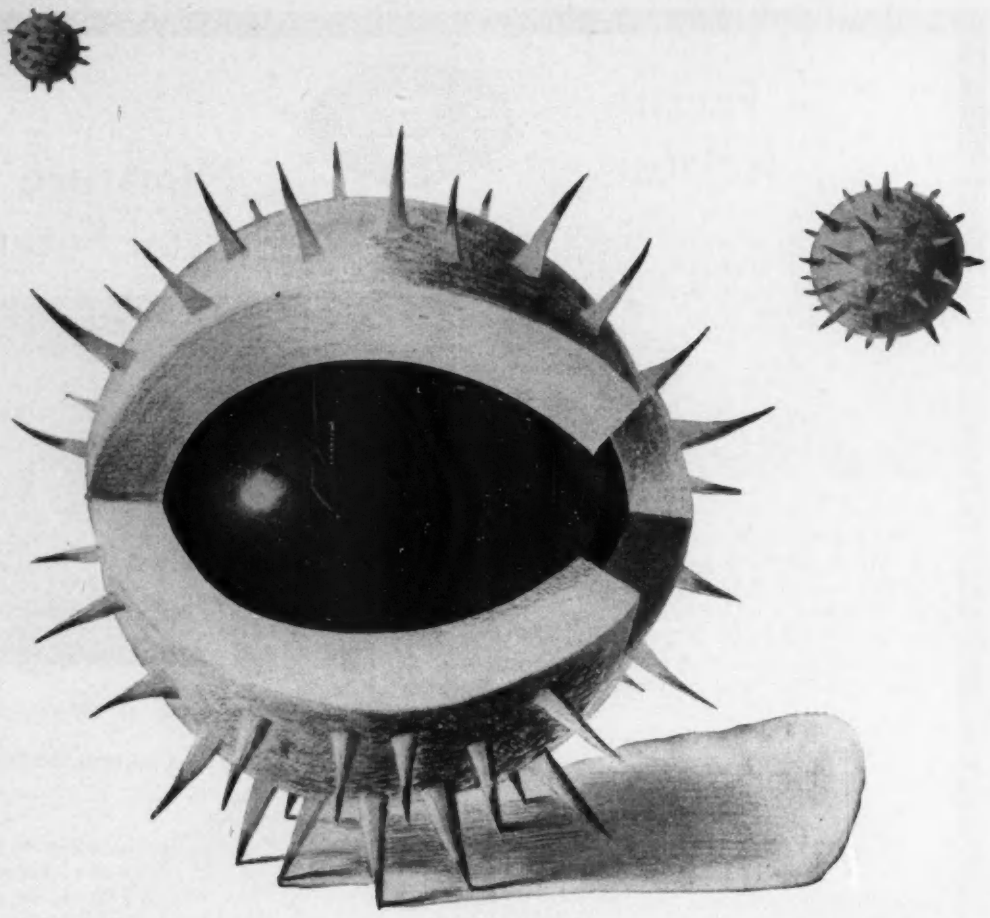

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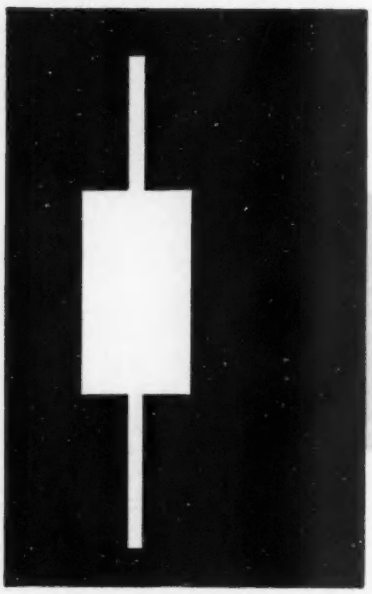

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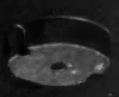

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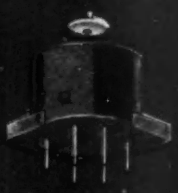

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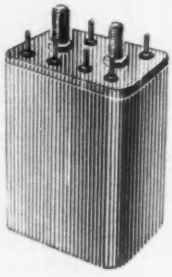
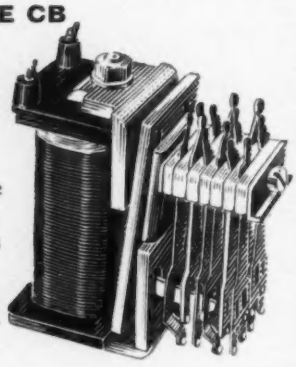
relays...

MINIATURE TYPE CA



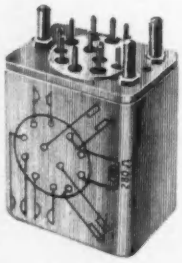
Fully Type Approved to RCS 165 and 166.
Light and medium duty types have two changeover contacts.
Heavy duty types single make or break.
Available sealed, or unsealed with dustcover.

MINIATURE TYPE CB



Based on Type CA with heavier magnetic circuit.
All versions fully Type Approved.
Available with up to twelve springs.
Twinned platinum contacts on light duty versions.
Available sealed, or unsealed with dustcover.

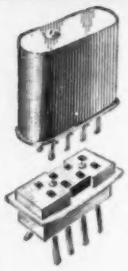
MINIATURE TYPE CC



Meets RCS 165 and MIL-R-5757 Specifications.
Based on Type CA magnetic circuit, providing up to four light or medium-duty contact sets.
Available sealed, or unsealed with dustcover.
Printed circuit versions available.

Contact loadings up to 10A d.c., non-inductive, can be arranged for Types CA, CB, and CC.

SUB-MINIATURE TYPE CE

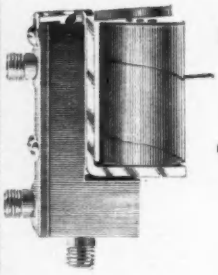


Occupies less than ¼ square inch of chassis area.
Two changeover contacts rated 0.25A at 28 V d.c.
Insulation proof against 500 V a.c., r.m.s. between coil and contact stack.
−55°C to +100°C operational temperature range.

PANEL SEAL CO-AXIAL TYPE CX

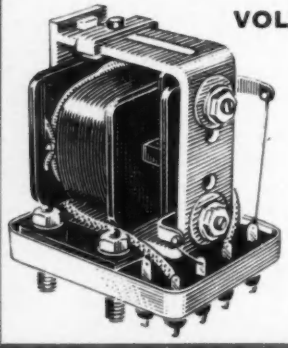
Meets Spec. DEF 5000 for materials and finish.
Single pole changeover, rated at 30W RF in 50 ohms.
0.05 dB max. loss up to 400 Mc/s.
Crosstalk better than 40 dB down.

MINIATURE CO-AXIAL TYPE CY



Single pole changeover, rated at 1W RF in 50 ohms.
0.05 dB max. loss up to appx. 100 Mc/s.
−55°C to +100°C operational temperature range.
Better than 100 megohms insulation resistance at 250 V d.c.

VOLTAGE REGULATING TYPE XC 269



Fully Approved to S.R.D.E. Spec. 166/1.
Temperature compensated in range −40°C to +85°C.
Available for 6, 12 or 24 V operation.
Typical changeover voltage differential 1 V in 24 V.

meet the latest electronic requirements

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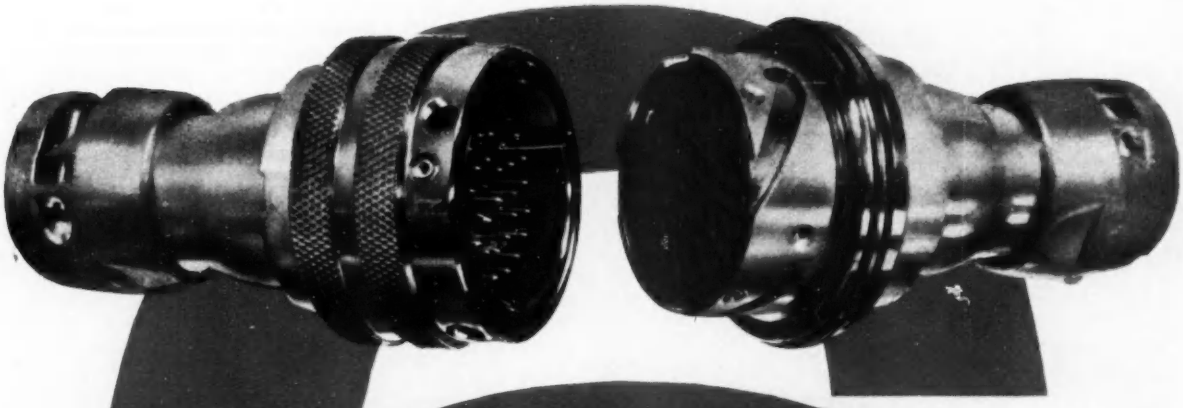
EE 34 104 *for further details*

Plessey MARK 6

A new conception in high performance connectors
with 6 outstanding features *



* Crimped connections
* -55°c to + 155°c
* Bayonet Coupling
* 6 to 55 contacts
* Pressure sealed
* 1kV. all contacts

The new Plessey Aluminium Mark 6 is an entirely new conception in electrical connectors—offering a greater number of contacts than the ubiquitous Mark 4 plus other singular features introduced to meet the exacting requirements of this modern age.

To the aircraft and missile designer, it offers a considerable saving in weight plus efficient operation and dependable service over an extremely extensive temperature range. To the designer of electronic equipment it offers a high standard of performance with valuable space-saving dimensions.

To all users of electrical connectors, the Plessey Mark 6 Connector constitutes the latest example of forward-thinking design and unsurpassed efficiency from a Company recognised throughout the world as one of the leading manufacturers of high quality, reliable electrical connectors.

Wiring and Connectors Division

THE PLESSEY COMPANY LIMITED

COMPONENT TRENDS IN THE SIXTIES—*STAND 310*

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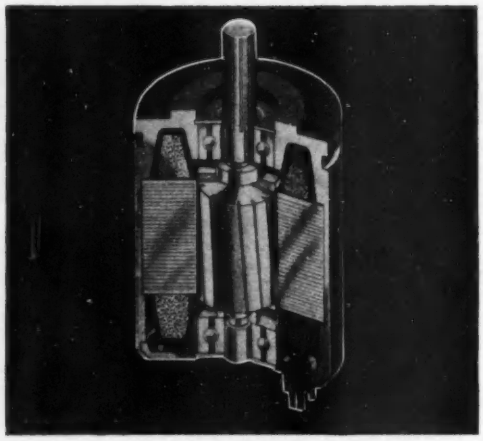


Combining precision engineering with rapid response and stability of performance over a wide temperature range, Ketay Size 08 Synchros and Servomotors have been developed as part of a continuous programme to provide miniature components of improved performance and environmental resistance. Both Synchros and Servomotors have encapsulated stators, nickel alloy laminations and hermetically sealed windings which make the units essentially corrosion resistant.

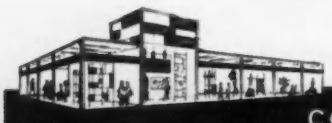
08 SYNCHROS

- High accuracy: less than ± 7 minutes of arc error
- Temperature range: minus 55°C to plus 77°C (special version for 150°C will be available)
- Light weight: only 1.5 ounces (43 grams)
- High torque gradient: pre-loaded stainless steel bearings
- Stainless steel housings: through-bore construction

08 SERVOMOTORS

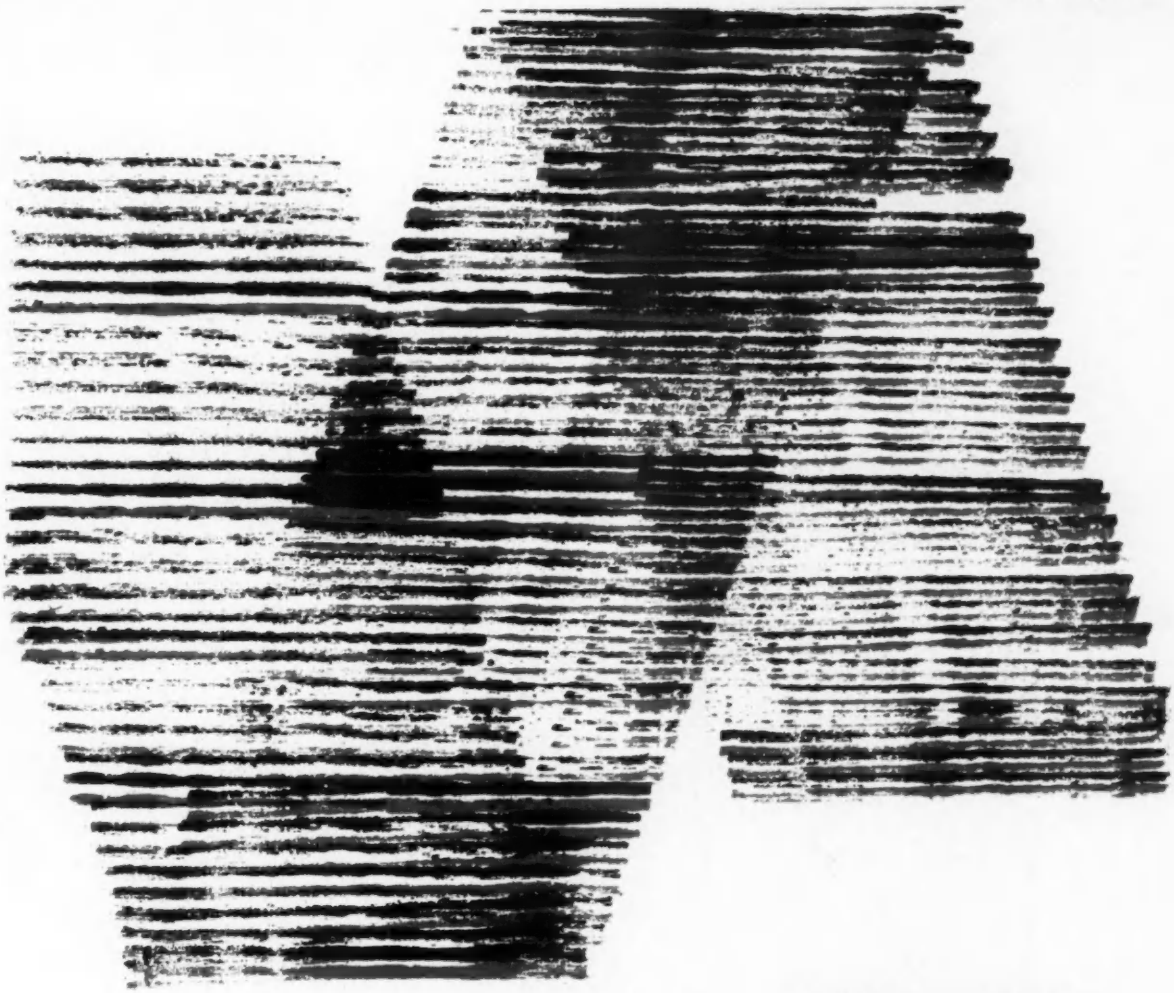
- Outstanding high ratio of stall torque to power input (0.22 oz. in. for 1.75 watts control phase)
- High rate of acceleration from stall condition
- Temperature range: minus 55°C to plus 125°C.

Ketay LIMITED



COMPONENT TRENDS IN THE SIXTIES—*STAND 310*

EE 34 106 *for further details*



just mention **vibration**

and accelerometer G170 goes all piezoelectric

Operating over a frequency range of 5 c/s to 3.5 kc/s, it will measure shock and vibration from 0.1 to 400 g in a wide variety of applications. Its light weight (5 gm.) and small size make it exactly right for measurements and tests on component parts as well as complete assemblies. These TCL accelerometers will operate over the range −40 to +80°C. They are sealed, impervious to humidity changes, and are fully reliable even under adverse operating conditions.

Other TCL types—G88 and G155 (high-sensitivity piezoelectric accelerometers)—are well-established in the ground and flight testing of aircraft engines and components. They are also used for measurements on vibration-absorbent mountings in road and rail transport and in the development of shockproof packaging.

TCL

TCL are ready to help you in today's problems of shock and vibration measurement. Please write or phone for more details.

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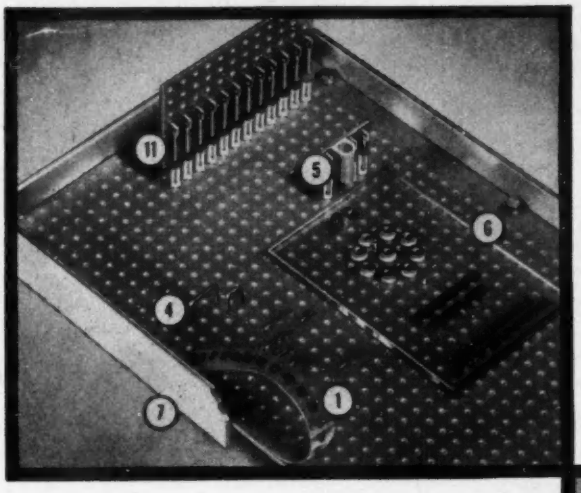
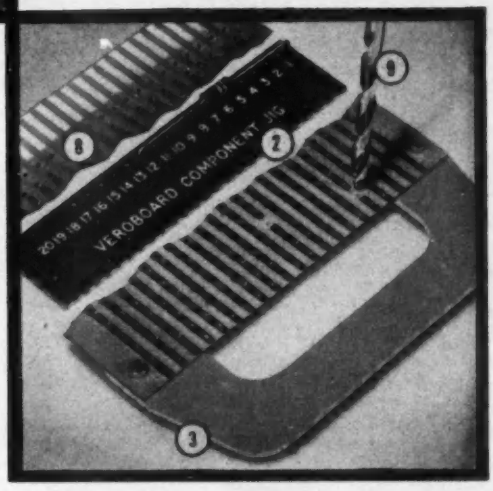
Fast, simple, low-cost circuit assembly



with **vero board accessories**



VEROBOARD is the universal wiring board that combines all merits of the printed circuit technique—*without the expense!* Simplicity, speed, cheapness, and reliability are the direct results of the VEROBOARD principle: standard pitching of standard-size holes on a resin-bonded laminate board backed by bonded copper continuity strips.

The following assembly aids and accessories are offered to speed and simplify the assembly of VEROBOARD circuits even further; and to provide even better service in use.

1 **Numeral tape** (self-adhesive) for fast, accurate reference to positions on VEROBOARD. 1–90 for 18″ boards and 1–30 for boards up to 6″. Part Nos. VB3021 and VB3022

2 **Component Jig** for bending wire terminations accurately to fit VEROBOARD matrix. Part No. VB 3031

3 **Plastic Handles** for plug-in VEROBOARD card circuits. Part Nos. VB3051 (black) and VB3052 (red)

4 **Jumper Links** of tinned copper wire for cross connections between bonded copper backing strips on VEROBOARD. Part Nos. VB3061 (0·2″) and VB3062 (0·4″)

5 **Semiconductor Holders** for mounting transistors, etc. with plug-in contacts on 0·2″ matrix. Part No. VB2011 and VB2012

6 **Valveholder Templates** for drilling holes at correct pitch and location on VEROBOARD. Part Nos. VB3041, VB3042 and VB3043

7 **Extruded Edging** in light alloy for strengthening VEROBOARD panels. Part No. VB3091

8 **Plug-in Panels**: 4·8″ × 5·8″ VEROBOARD, gold-plated at one end for use with edge connectors. Part No. VB2001

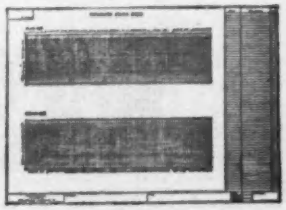
9 **Spotface Cutter** to make a clean separation where necessary in copper backing strip. Part No. VB3011

10 **Design Sheets** on high quality tracing paper for designing circuits on VEROBOARD and for producing workshop prints. Part Nos. VB3071 (18″) and VB3072 (6″)

11 **Varicon Connectors** which can be used as single point contacts or in rows to form connections between VEROBOARDS. Available in strips of 20. Part No. VB3081 (in line and VB3082 (right angle).

Notching Tool for Extruded Edging to enable it to be mitred for making corners and for slotting to take VEROBOARD panels. Part Nos. VB3101 Press, VB3102 Mitre die set, VB3103 Slotting die set.

VEROBOARD Kit contains supply of VEROBOARD and accessories.



vero board

is a product of VERO Precision Engineering Ltd., South Mill Road, Southampton. Telephone: 71061/4

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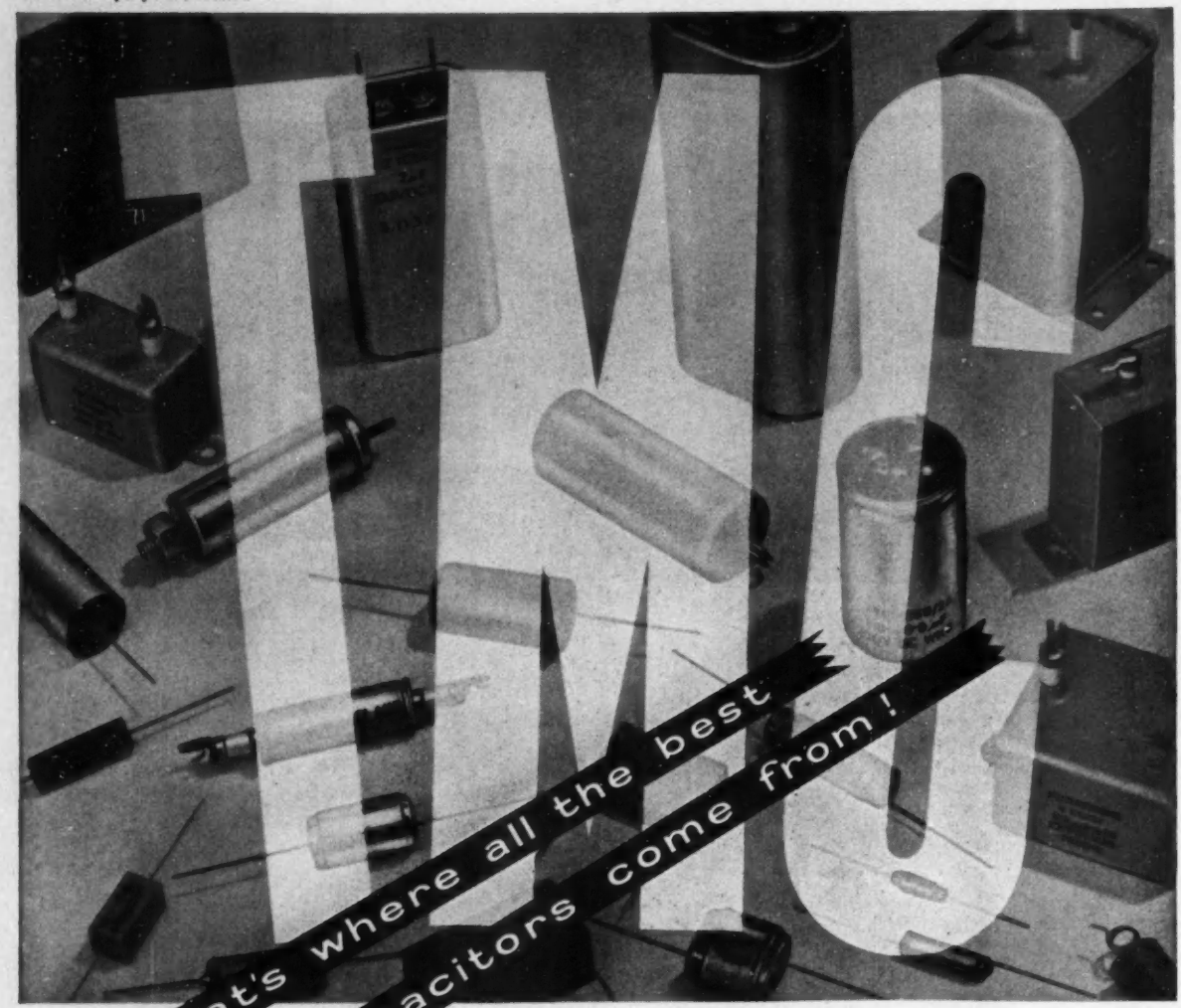

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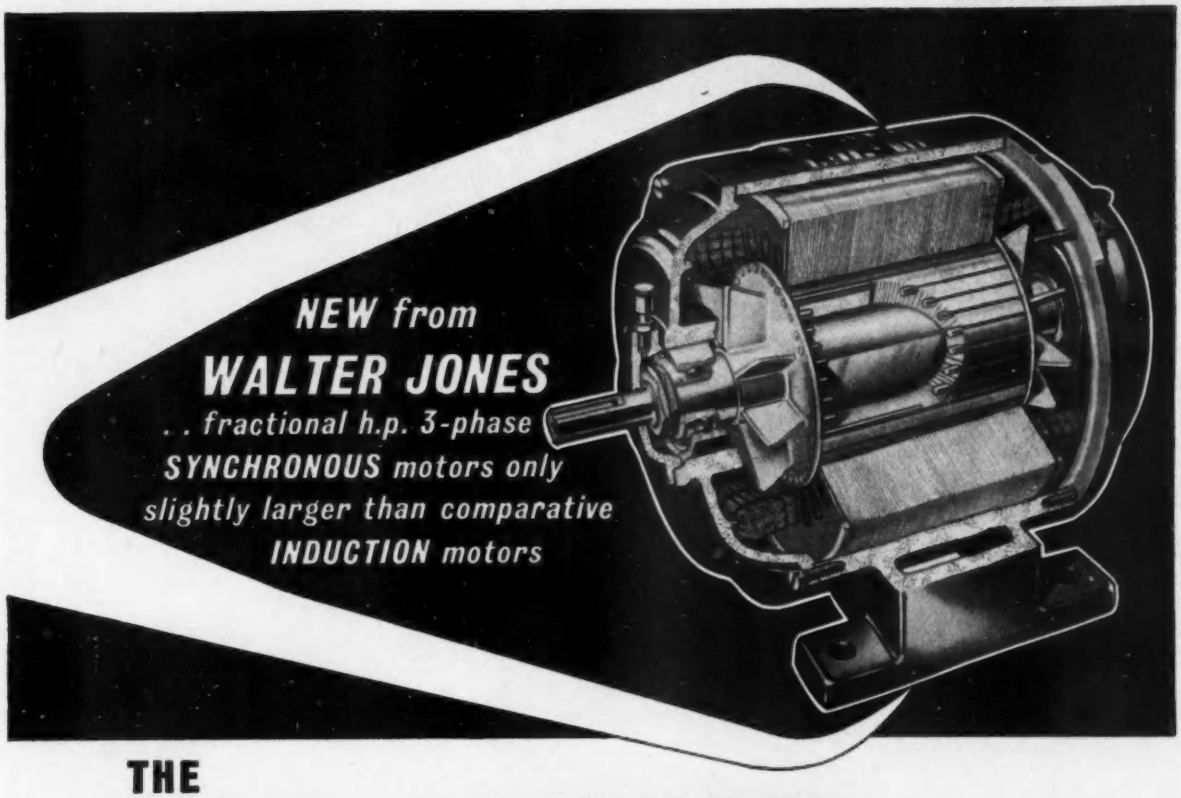

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Frame size		012	017	N15	N22	M20	M30	L25	L39
50 c.p.s. 2-pole 3000 RPM	HP	·04	·06	·10	·16	·22	·38	·46	·75
50 c.p.s. 4-pole 1500 RPM	HP	·025	·033	·07	·10	·15	·22	·33	·50
400 c.p.s. 4-pole 12,000 RPM	HP	·20	·28	·50	·75				

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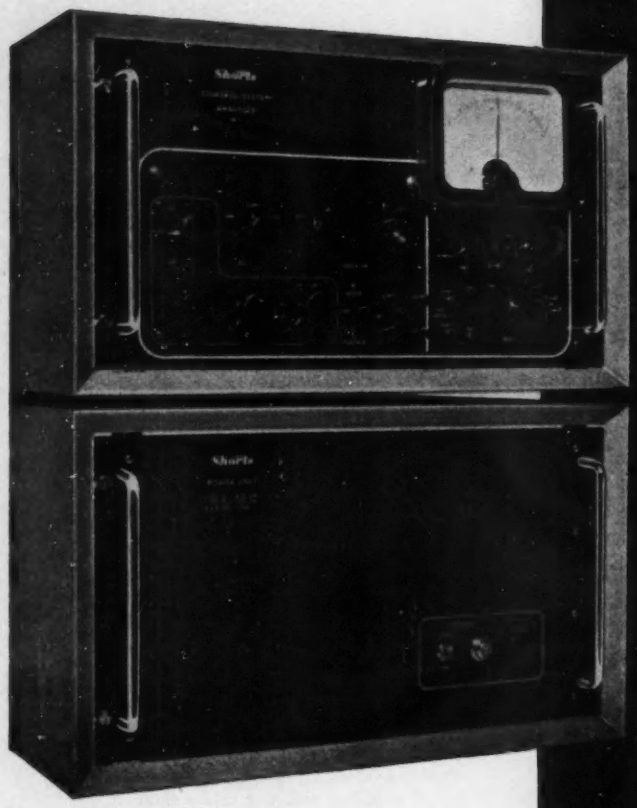
The Analyser incorporates the Short Low Frequency Oscillator.



- Steady inphase and quadrature readings.
- Complete rejection of system D.C.
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- D.C. content less than 0.0005%.
- Sine and cosine distortion less than 0.5%.
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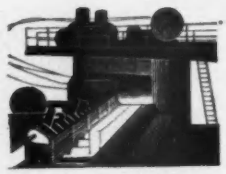
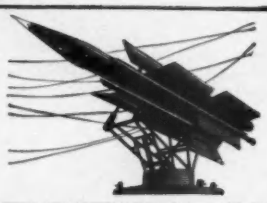
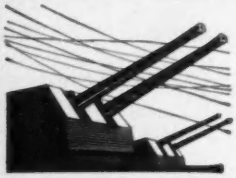


Control of rolling mill and mining machinery

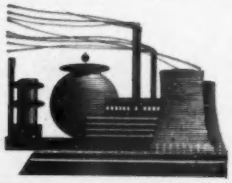
Design of heavy crane control gear



Missile servo analysis



Gun control problems



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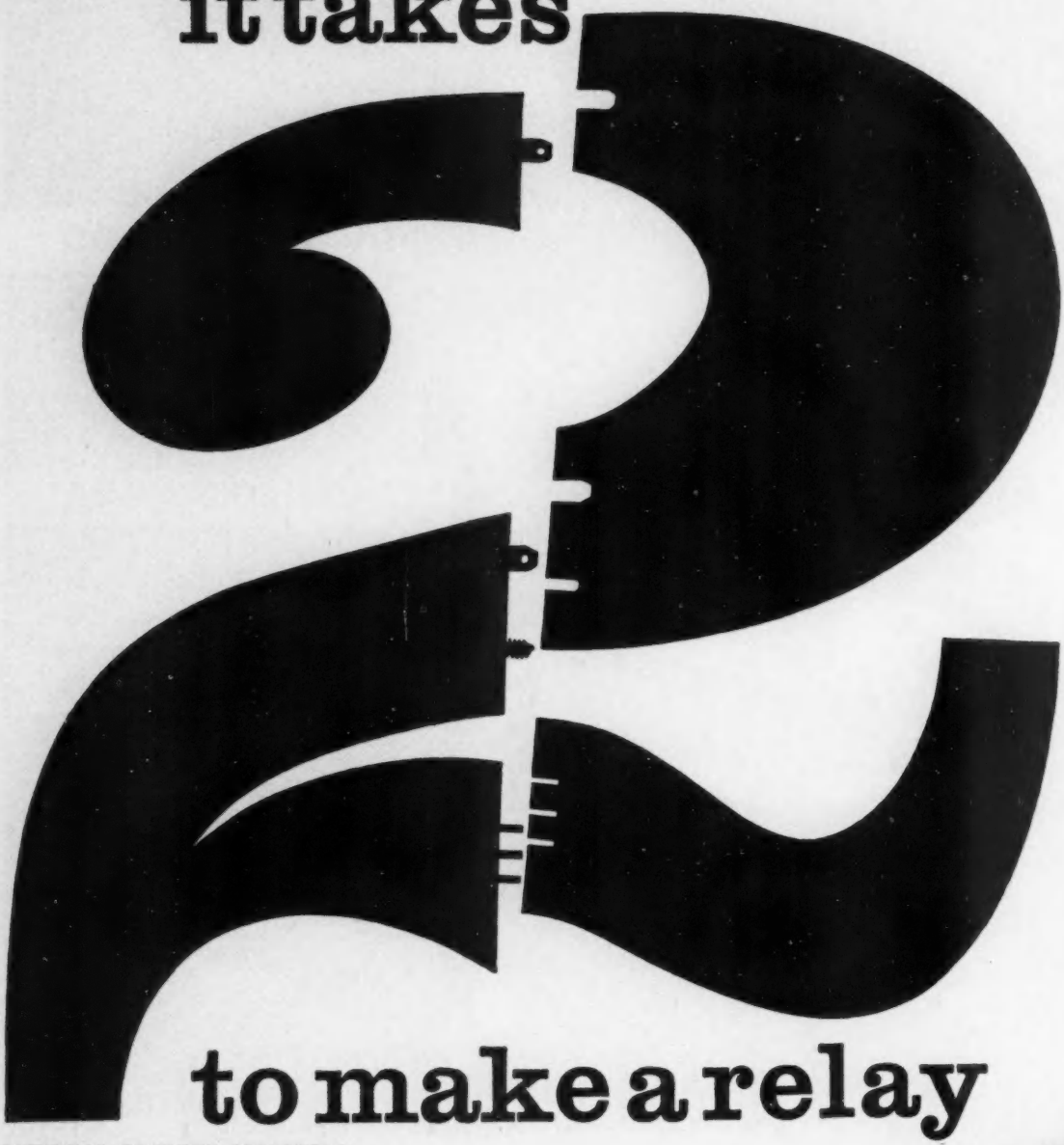

to make a relay

NEW FOR PRINTED CIRCUITS!

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•2, 4 and 6 pole sockets available •No 'bridge' connections needed •Pin spacing conforms to 0.15″ module •Socket pin sizes are correct for standard hole sizes in the printed board.

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The Siemens & Halske Miniature Type Relay 154C

The Siemens & Halske Printed Circuit Socket Type 24C.

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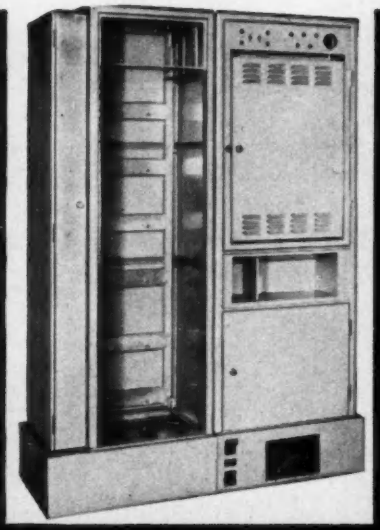

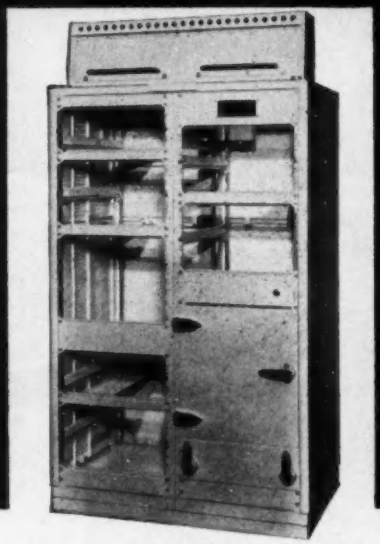

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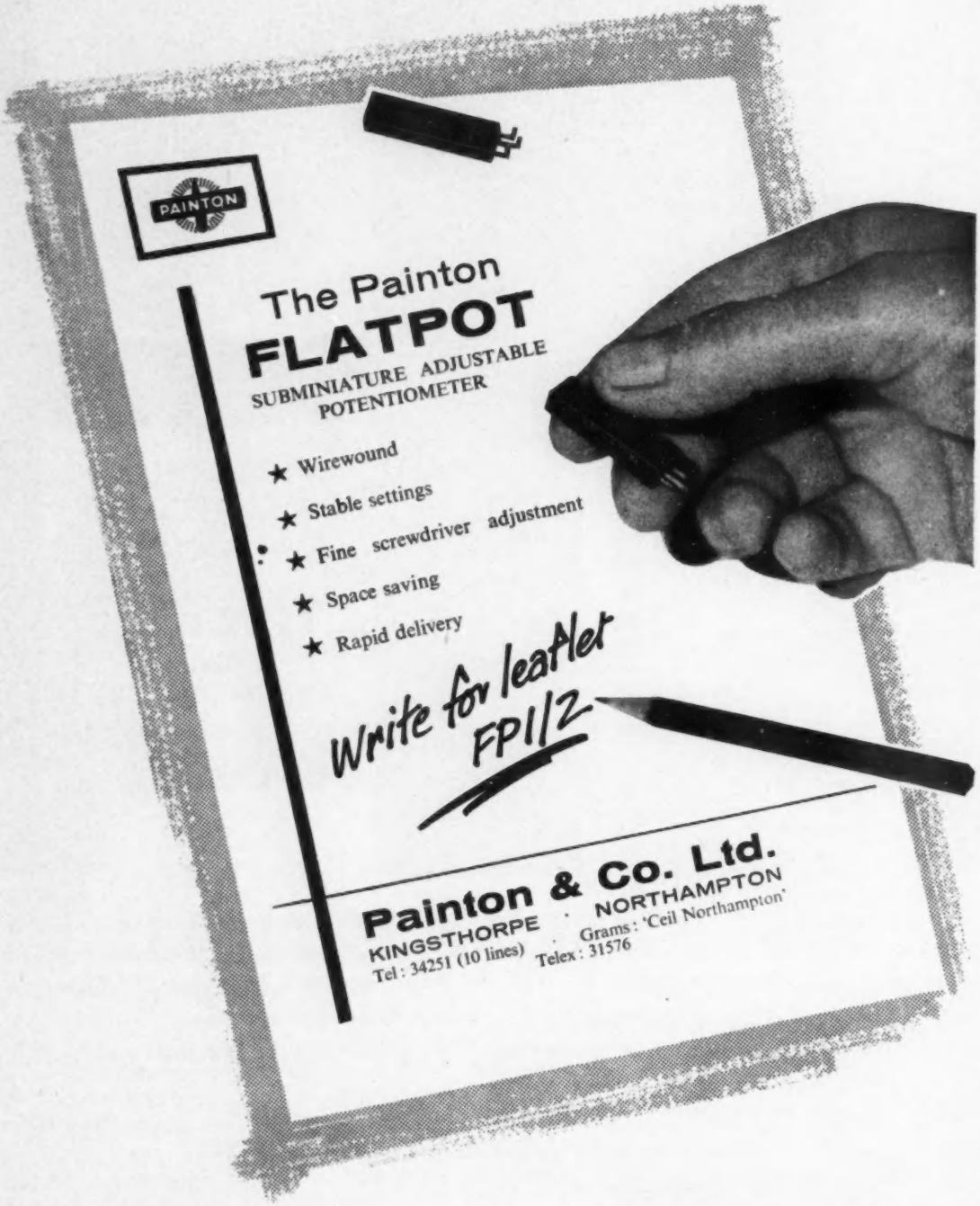
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16, 18 or 20 turret stations

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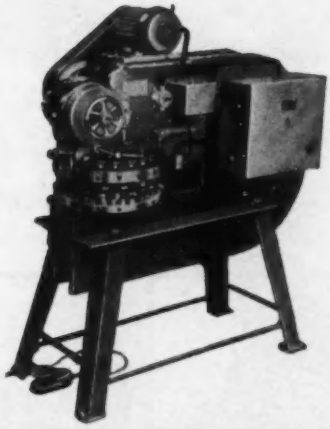

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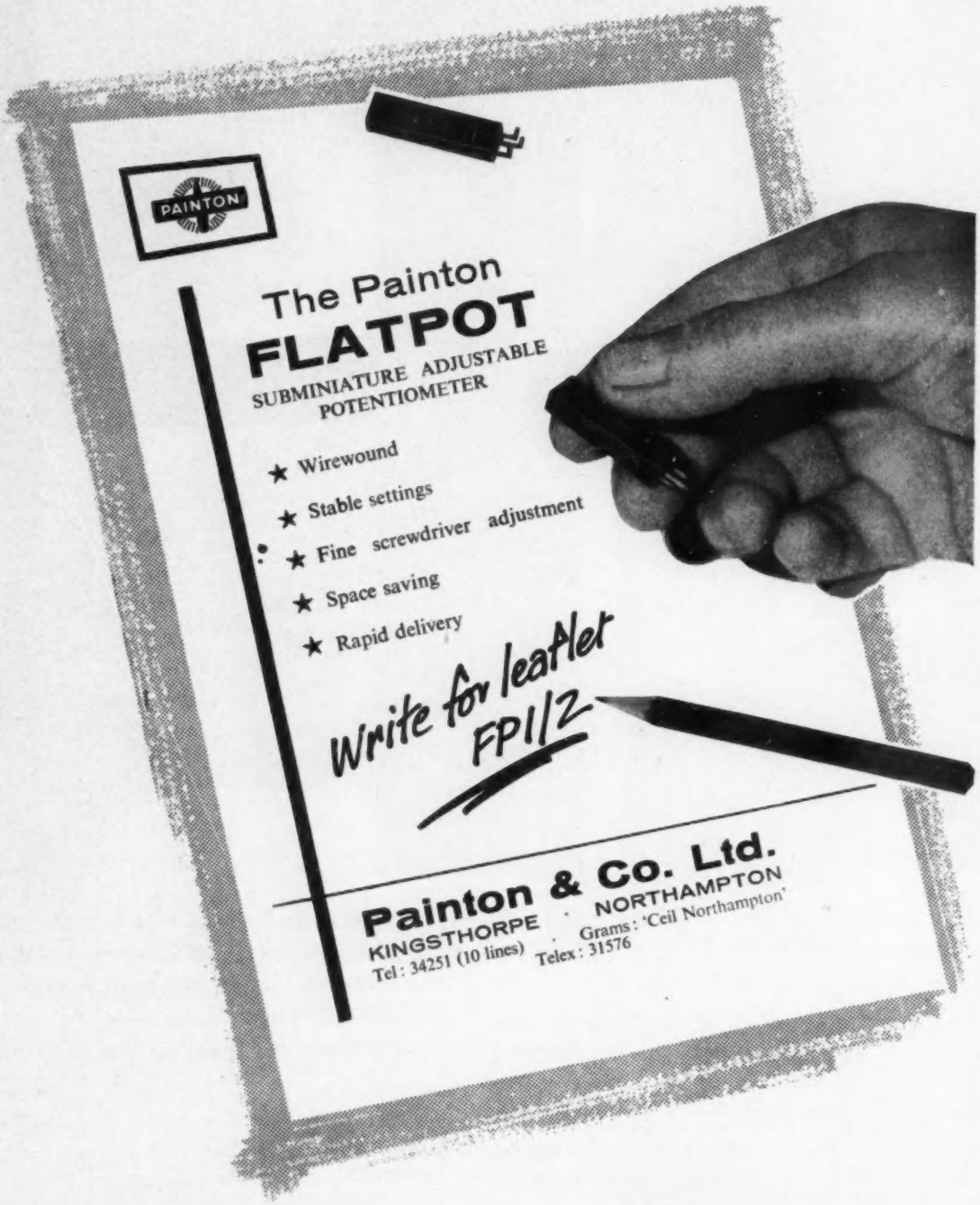
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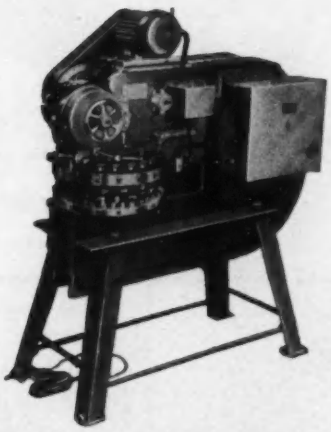

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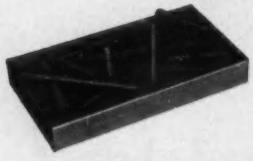
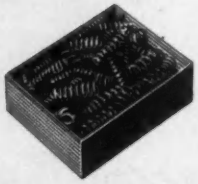
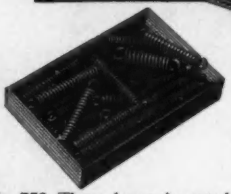


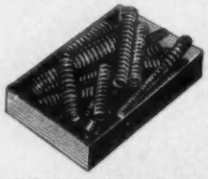
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-.**



No. 98A. Three dozen Assorted 1″ to 4″ long, ¼″ to ⅝″ diam., 19G to 15G. **6/6.**



No. 753. Three dozen Assorted Light Expansion ¼″ to ½″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **12/-.**



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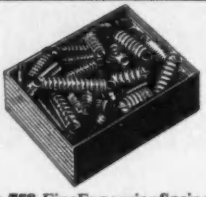

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HT31

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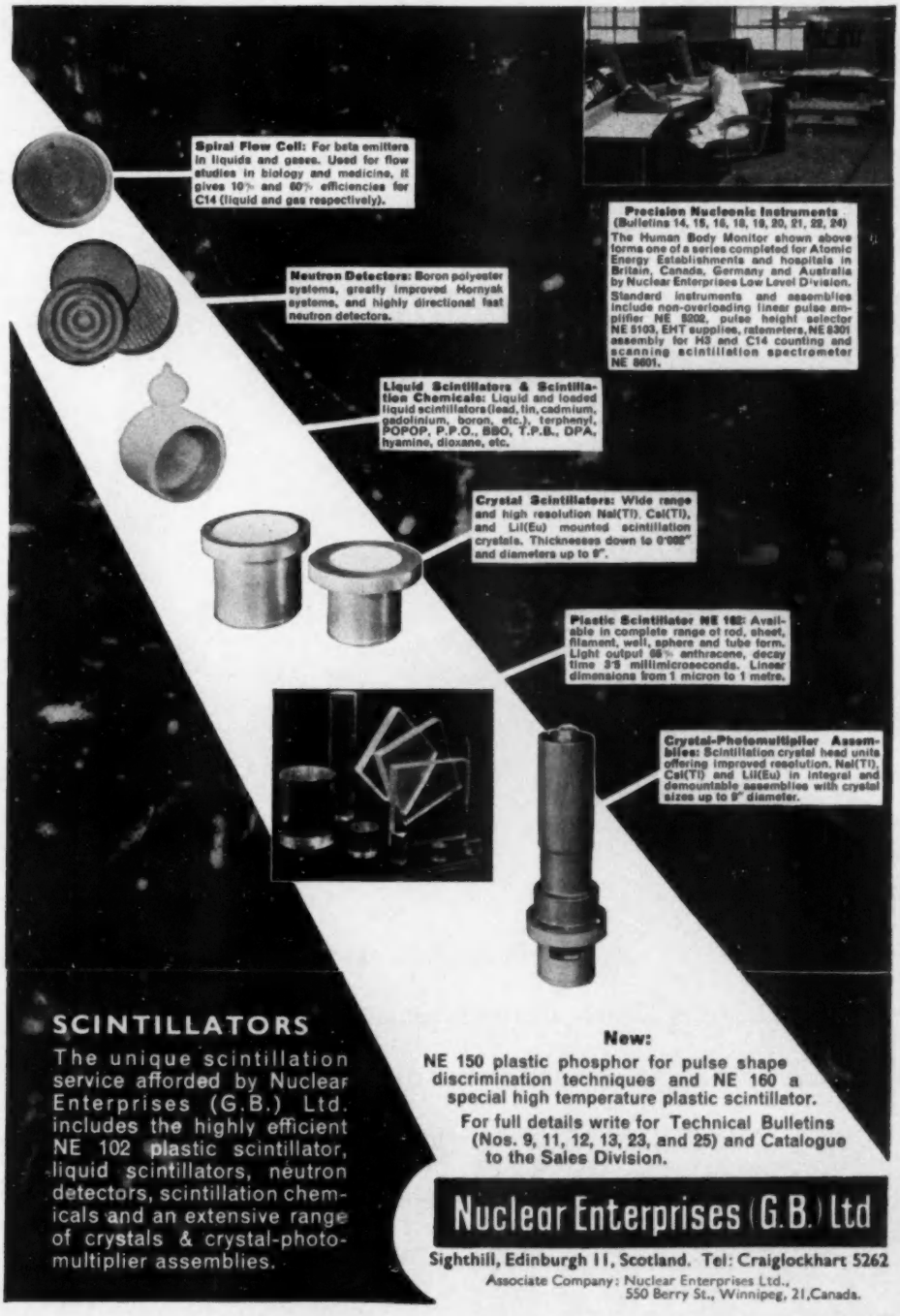
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"Desperate Joker"

Cocklehampton

Dear Joker,

Thank you for your desperate joke. We could certainly use it. But what for is a little difficult to say. You see we would like to get in a mention of our Q-band mixer diodes and low-noise preamplifier transistors as well. We make a wide range of semiconductor diodes - and we want people to ask us for them.

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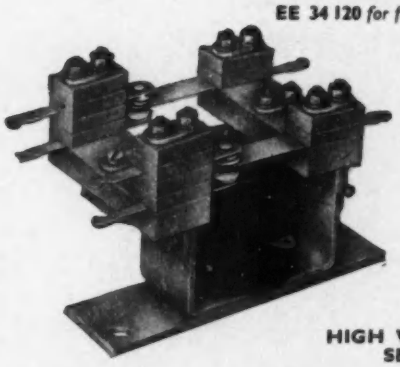

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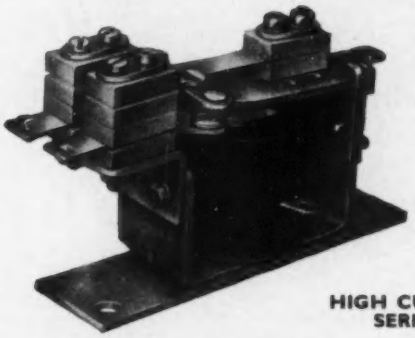

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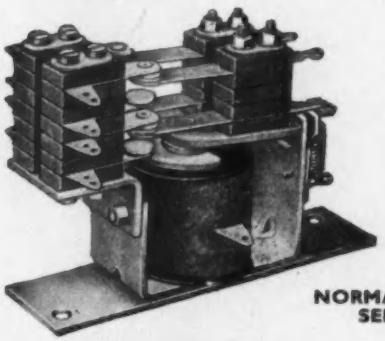

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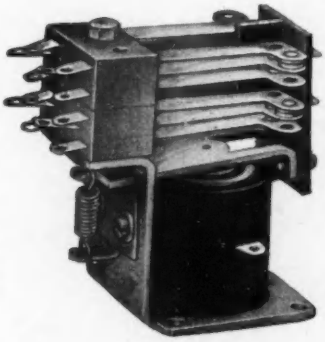

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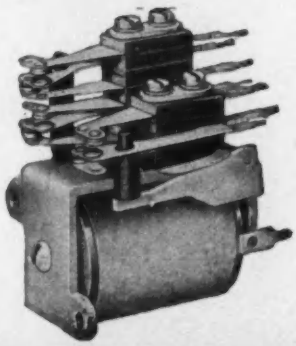

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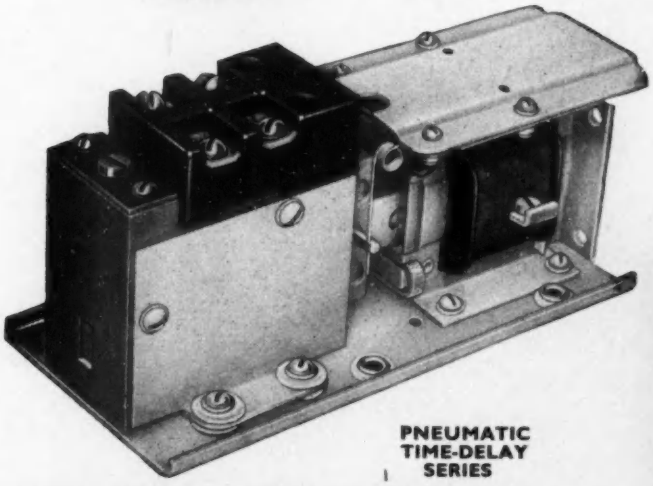

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and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.

fig. 1 Gain characteristics

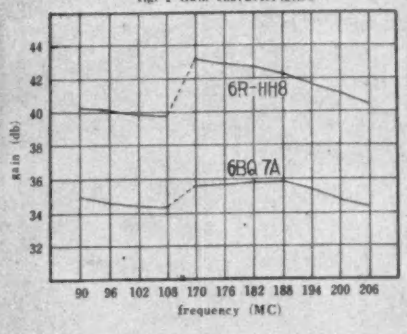
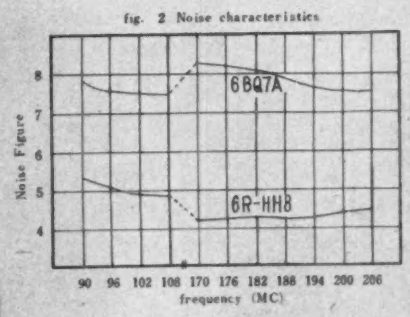
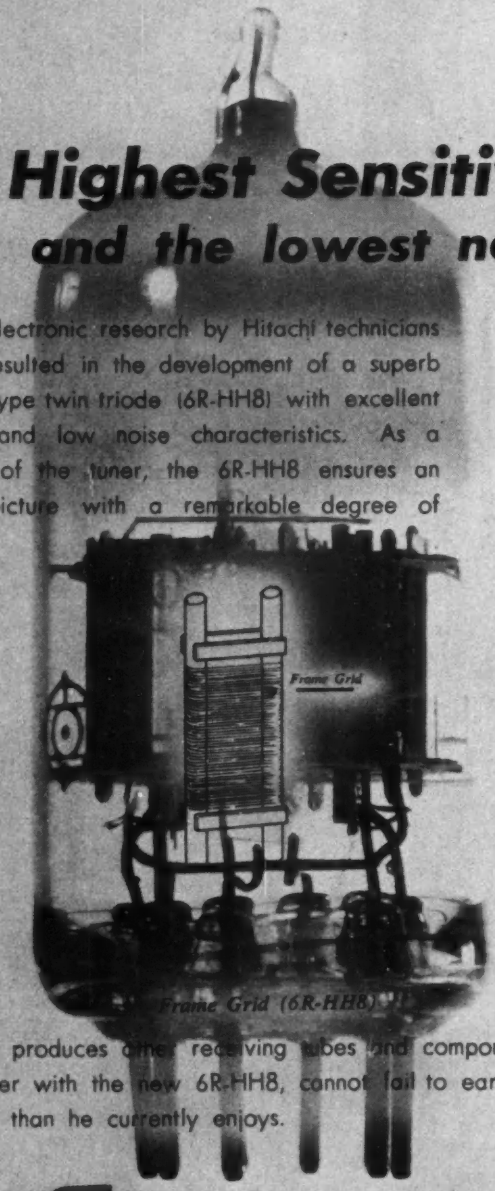


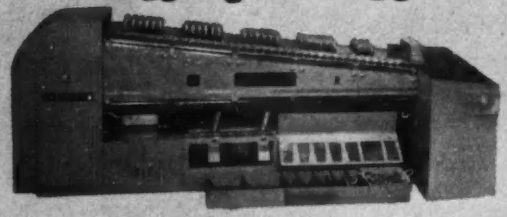
fig. 2 Noise characteristics





Frame Grid (6R-HH8)

Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.



Automatic tube testing equipment

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Tokyo Japan
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This is news!

now...a *transistorized* chopper

Price in the U.K. for small quantities, available from stock, £8.5.0d.
Unsealed versions of the SM.10 transistorized chopper are in use in the control systems of British Nuclear Power Stations and have already given three years trouble-free service—Thus proving their stability and reliability.

New from TMC comes the ELECTRONIC MODULATOR SM. 10—the first fully encapsulated transistorized chopper to be produced and sold in quantity in Gt. Britain. The SM. 10 is a highly stable, clamp-type chopper with silicon transistors, designed for low level d.c. chopping. Unlike electro-mechanical choppers, the S.M. 10 has no moving parts to wear, or contacts to become contaminated. What is more, it will never need adjustment!

The SM. 10 has all these advantages:

- Noise level so low that it will switch a voltage of one microvolt.
- Extremely high stability over the temperature range 0° to + 55°C.
- Carefully matched, selected components give low drift and almost limitless life.
- Will operate from any 6 volt sinusoidal or square-wave supply—at frequencies from 40 c/s to 1000 c/s.
- Small and compact—fits B9A socket and measures only 1⅛" × 1¼" diameter.
- Epoxy resin cast and aluminium encapsulated—will withstand excessive vibration and shock effects (suitable for all military and commercial projects).

See these and other TMC components on Stand 304 at the Radio and Electronic Components Exhibition.

The SM. 10 is designed and manufactured by Bailey Meters and Controls Limited, and marketed by:—

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		DC as for AC plus 1000V	-----	-----	----	10MΩ		
V 12	DC Valve Voltmeter Microammeter	1, 3, 10, 30, 100, 300 1000V, DC	0.1, 0.3, 1, 3, 10, 30, 100, μA	----	----	20MΩ balanced or 10MΩ unbalanced	±3% and 1% 24 hour stability	£61. 0. 0
V 15	Sensitive Valve Voltmeter	30, 100, 300mV 1, 3, 10, 30, 100, 300V, AC	----	----	40 c/s to 500 kc/s	3MΩ 35 pf	±3%	£49. 10. 0
V 17	Universal DC Meter	1, 10, 100 1000V, DC	0.1, 1, 10, 100, μA DC	10Ω to 1MΩ 4 ranges, 3V DC test potential	----	10MΩ for voltage 10MΩ to 1 KΩ for current	±2%	£60. 0. 0

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Look at the performance of these four NASHTON Voltmeters, then look at their prices—they are of outstanding value for money. But that's not all—they bring a new economy to production inspection and laboratory tests by speeding them up. They are designed for ease and simplicity of use and for rapid, mistake-free, repetitive readings under realistic working conditions. Invest in NASHTON accuracy at NASHTON Economic Engineering prices—speed up the vast bulk of your work by quick, dependable, time-saving readings.

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ELECTRONIC ENGINEERING

VOL. 33 No. 400

JUNE 1961

Commentary

THE announcement that a Russian—Major Yuri Gagarin—has become the first man to throw off the shackles of this earth and venture into outer space has come as no great surprise for it has been expected for some time past, and now that it has become an accomplished fact, praise should not be stinted.

Only the barest details have so far been released but to launch a rocket weighing several hundred tons to put a man in orbit round the earth and bring him and his space vehicle safely back again is no mean feat and may well be what has been described as "the greatest scientific achievement in the history of mankind". The Soviet scientists have every reason to feel satisfied with what has been accomplished so far and to have confidence in their plans for further exploration into outer space.

And in offering praise and congratulations to the Soviet scientists, a word should be added to Major Gagarin for his undoubted courage in becoming the world's first space traveller.

However now that the first excitement has abated somewhat it may be opportune to try to assess what has been achieved, with what results and at what cost.

Unquestionably it is an amazing technical feat—of that there can be no shadow of doubt—but its value as an instrument of political propaganda and military significance has completely overshadowed everything else and already claims are being made that "it has shown indisputably the incomparable superiority of the socialist system".

It shows of course nothing of the kind, nor could a similar statement have been made on behalf of the Western World had the Americans been the first to put a man into space.

If it shows nothing else, it does show what can be attained with sufficient single-mindedness of purpose when, regardless of the sacrifices its peoples may be called upon to make in other respects, a country's resources are directed to a single end.

No indication of the cost of Russia's space programme has been given—nor indeed is any figure likely to be forthcoming—and we can only turn to America to get an idea of the fantastic cost of present day space research.

Here again no separate figure for her space programme is quoted, but it has recently been stated that the U.S. Government is spending somewhat more than $40 billion a year (about £14 000M!) on "the maintenance of military establishments and the procurement of arms" which, the statement goes on to say "has absorbed about ten per cent of the gross national product and has exceeded by several billion dollars the combined net annual investment in manufacturing, service industries, transportation and agriculture".

If the cost were but a tenth of this gigantic sum it would still represent an inordinately large expenditure and those in this country who are so emphatic that we should enter the race into space on equal terms with the Russians and Americans would do well to bear these facts in mind.

The political prestige gained by the recent experiment cannot be denied and the military significance is overwhelming, but it is doubtful if the scientific results alone bear any relation to the cost.

Travel beyond the confines of the earth is now with us and in the future we can anticipate further journeyings by man with perhaps a landing on the moon.

But this is most certainly not for the masses.

Apart from all other considerations few of us have the necessary physique to start with or would be willing to undergo the long and arduous period of training required to become a space traveller.

Orbits then round the earth as a weekend pastime are in our view wholly unlikely, nor is mass emigration to the planets to be seriously considered at this stage as a means of relieving world overcrowding.

The most regrettable feature of this business of putting a man into space is that it has degenerated into a battle between the rival ideologies of East and West. We in this country have as yet taken little or no part and it is highly unlikely that we can compete alone on the same scale as the Russians and the Americans. The recent suggestion that we should combine with the countries of Western Europe therefore appears a wholly admirable one. Major Gagarin has by no means put an end to space research and in spite of the excellent contributions already made in America there is much that can be achieved by such a combined and properly co-ordinated effort.

Ideally, of course, the only solution is co-operation on a world basis but we on this earth are not sufficiently advanced in our political thinking to consider this.

Before very long a man—and presumably he will be a scientist—will land on the moon in order to see for himself but we share the view held by many, that the wholly instrumented space vehicle is the only logical tool for worthwhile space research, and we believe that in this direction there is much that this country can contribute.

THE SIGNAL SENTRY

A Solid State Monitoring and Alarm System

By M. L. Klein*, B.S., M.S., Ph.D., and J. P. Hart*, B.S.E.E.

In process control, medical work, and quality checking there has been a need for an all solid-state, precision, monitoring and alarm system. The 'Signal Sentry' provides 0·1 per cent monitoring accuracy on multiple input d.c. levels. In addition, internal monitoring of the unit itself on twelve critical voltages is provided. The unit consists of a solid-state multiplexor, all transistor digital voltmeter, and utilizes punched card programming and logic. All data that agrees with the program is discarded. Out of program data provides an alarm. Thirty channels can be scanned in less than 300msec permitting use for critical process control.

(Voir page 404 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 411)

PRESENT-DAY medical monitoring, process control and quality checking results in the accumulation of considerable quantities of numerical information. Customarily, this is processed by computer after acquisition in digital form or reduced by hand from analogue records. The requirements for monitoring dictate an ability to make instantaneous go/no-go decisions based on the numerical results obtained. This cannot be obtained using ordinary digital acquisition techniques because of the processing delay time. Conventionally, human monitors are used for on-line processes such as chemical reactions, medical operations, control of average outgoing quality level.

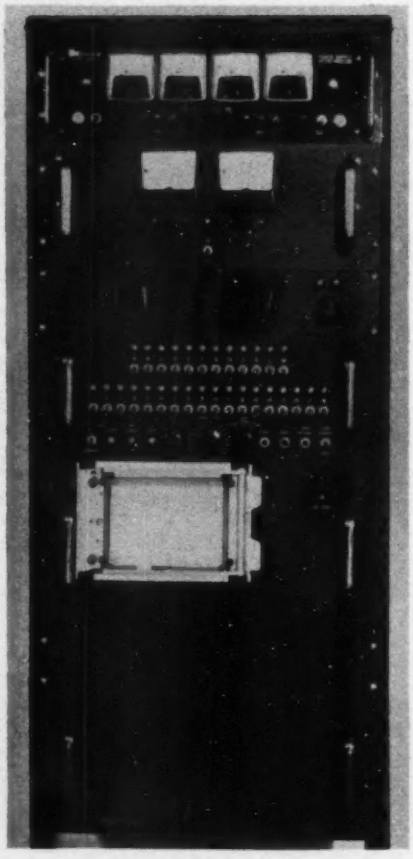
The 'Signal Sentry' was designed on the philosophy that acceptable data need not be recorded; merely logged as an acceptable reading. Unacceptable data which is defined as a datum point not falling within pre-selected bounds, requires immediate corrective action independent of a human monitor and separate logging as an unacceptable point.

Further, the reliability of the system should be inherent which infers the use of elements and components which do not erratically fail to operate. It would be desirable, as well, if the unit would check itself and indicate when it is failing to meet acceptable operational levels internally, suggesting the need for examination. Finally, the unit must be programmed simply and be capable of program changes with minimal time and effort by unskilled operators.

Such a unit has been constructed and is being field tested at a large computer organization for checking the quality parameters of transistors at a rate of over 50 000 daily. This is an application in the area of quality control. It is evident that chemical processes (where the parameters desired can be specified) lend themselves equally well for automatic monitoring and alarm. The present interest in human stress and limits of human endurance requires a similar monitoring of human beings.

* *Communications Control Corp., U.S.A.*

Fig. 1. The complete equipment



Description

The Signal Sentry is a fully solid-state device shown in Fig. 1. It accepts 18 input external d.c. voltages at 10V level. These, of course, are produced by the transducers for the functions to be monitored. It occupies 40in of rack space and does not exceed 18in in depth and weighs approximately 150lb. Total power consumption is approximately 100W. Referring to Fig. 1, the unit is organized, from top to bottom, with the two topmost chassis as power supplies. The third panel is a projection display providing numerical information on the data being read. The fourth chassis permits mode programming, to be described hereinafter, and contains all operational controls. The fifth chassis is the logic and associated card reader. The two lowermost chassis contain keying logic and the analogue-digital convertor, or digital voltmeter. Construction details are shown in Fig. 2 which shows part of the operational controls, the card sensor or reader with a partly inserted punched (Hollerith) card and one of the drawers with components. Hand wiring is used extensively to permit field maintenance by relatively inexperienced personnel avoiding the usual destruction of printed circuits during field changes. Solid-state circuits and modular construction

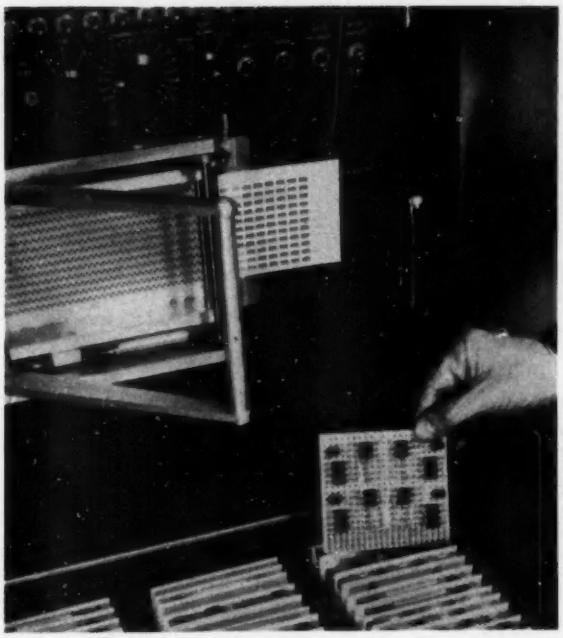


Fig. 2. Part of the equipment showing constructional details

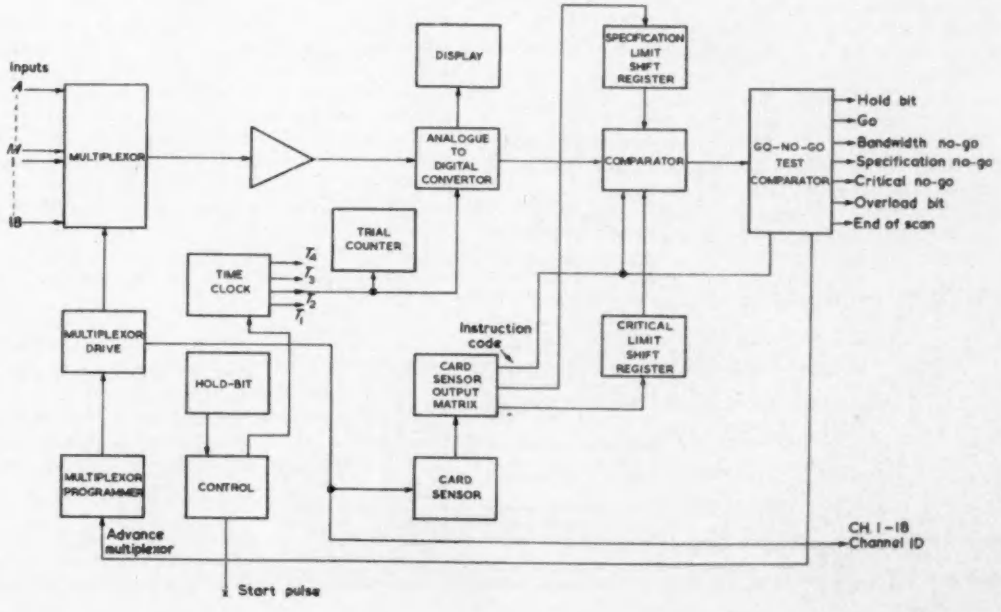
is employed throughout. The signal flow is shown in block form in Fig. 3, showing the high speed, precision switching of the input analogue signals by the solid-state multiplexor, the conversion to digital form and the logic tests and programming.

Functional Operation

In use, the unit is driven by the eighteen (more if desired) 10V single ended analogue signals. One of three operating modes is selected for the unit, interchangeable from channel to channel. One operating mode is known as bandwidth test wherein the desired parameter for a channel falls within two desired three decimal digits for acceptance. For example, channel one is selected for bandwidth test establishing acceptable values as greater than 305 and less than 834. The first of these numbers is punched in binary coded decimal in the first column of the Hollerith card, the second in the third column. Twelve digits are available in each card column (although only ten actually appear as printed numbers on the card to begin with). The second or middle column is punched to indicate the test mode. The second possible test is called lower-absolutely low permitting an indication of a trend to an outer bound. Using the same numbers, say, the Signal Sentry would give an alarm when the parameter fell below 305. This is programmed on the card in exactly the same way changing only the middle column mode code, The third possible test is upper-absolutely upper which reverses the situation. The use of these separately or jointly, provides a means of logging trend and providing notice of impending trouble before the point of trouble is actually reached. It is, in a sense, the electronic analogue of the cumbersome trend charts now used for quality control. Subsidiary printers and counters can be used to log any or all of the counts yielding direct quality control data without using computing techniques. After inserting the input voltages and establishing the test programming by punching and inserting the card, the scale factors are established. The unit is manually stepped from channel to channel with standard voltages as input to each channel. The convertor displays the reading for that channel and a manual adjustment of the input potentiometer provided for each manual channel yields the insertion of the scale factor.

To begin operation, the user selects the number of channels to be scanned. Twelve internal channels are always scanned to assure proper operation of the Signal

Fig. 3. Signal flow diagram



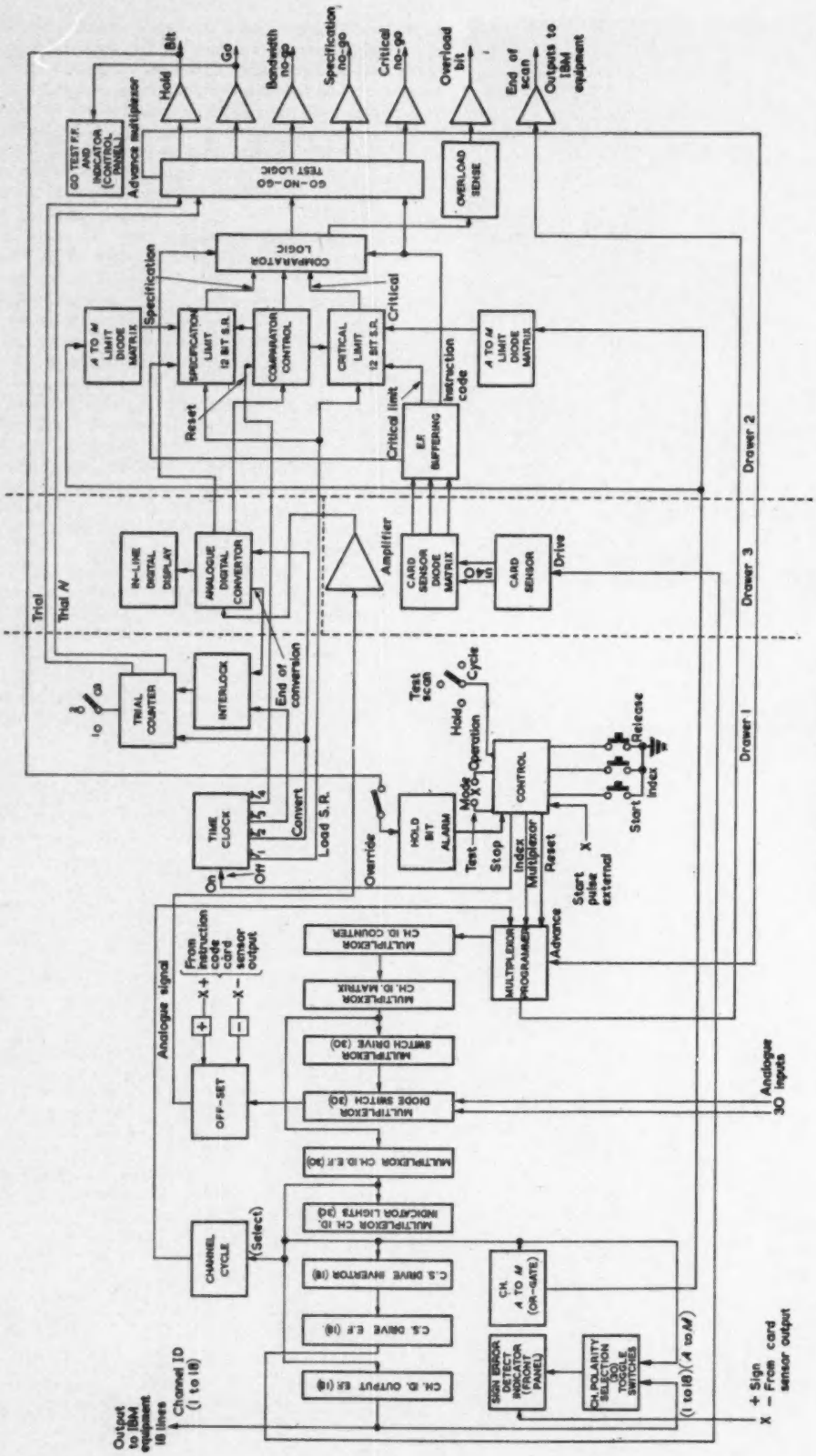


Fig. 4. General arrangement of the equipment
C.S.—Card sensor; E.F.—Emitter-follower; F.F.—Flip-flop; S.R.—Shift register; CH.—Channel; ID.—Identification A-M Analogue input channels, A to M 1-18 Analogue input channels, 1 to 18

Sentry, but one to eighteen channels can be dialled for the external cycle of readings. Further, one to three trials are selected for each channel which means that if the unit finds an unacceptable reading on any channel (owing to momentary spurious signal or noise) it will make one or two more attempts, as dialled, before providing an alarm.

Alarm signals are provided by circuit closure along with a visual indication of the channel in error. If one of the twelve internal channels is unacceptable, a separate alarm is given and the progress of the unit stops completely for maintenance or correction.

In temperatures of 40 to 95°F, long term accuracy, including drift is plus or minus 0·1 per cent. Normally, recalibration is required only once every six months and no maintenance is required other than occasional replacement of the lights in the numerical display units.

System Analysis

An analysis of the system can be started with Fig. 4. The system is basically a closed loop operational sequence. The multiplexor appears on the left, along with its driver and programmer unit. After amplification, the signals are fed to the analogue digital convertor, and after being quantized (or digitized) they are compared with the pre-selected values for each channel. This comparator derives its pre-selected values from a standard IBM punched card and a sensor, manufactured by the Taurus Corporation, which simultaneously reads all punched holes. Subsidiary logic feeds the preselected value at the correct time to the comparator. Subsidiary logic, shown in the lower left, synchronizes the overall operation of the system and the various output modes. Channels *A* to *M* consist of twelve normalized parameters reserved for monitoring test set-up parameters. The remaining 18 channels are used to sample test parameters. In normal operation, an external start pulse is provided to the system to actuate control circuits which in turn programs the multiplexor to sample each channel in sequence. During each sample time an internal time clock provides a sequence of four timing pulses. These timing pulses are in turn used to synchronize the sampling of the analogue to digital convertor and the subsequent transfer of information to the system. The element referred to as card sensor includes a mechanism for sensing numbers from a stored IBM punched card. These numbers, programmed limits, are compared by the comparator with the digitized number from the convertor. A specification limit and critical limit is therefore obtained from the card sensor by means of an output matrix and stored in the respective shift registers. Subsequently, the results of the comparison are examined by go/no-go test logic to determine the various outputs in accordance with the instruction code also obtained from the card sensor. The results of these tests, made on a channel basis, are provided as seven individual outputs. Separate channel identification voltage levels are also provided as outputs for channels 1 to 18.

Components

The analogue digital convertor is well known in the literature and is a fully transistorized unit capable of 2 000 conversions per second with an accuracy of one part in a thousand including linearity and drift. Commercial fully transistorized power supplies are used throughout.

Circuits

The remainder of the analogue and digital circuits of the system are located in chassis 1, 2, and 3. The locations, designations, and inter-connexions of the various circuit elements, such as flip-flops, gates, etc., are shown in the applicable logic block diagram.

The following discussion considers the various groupings of circuits with respect to function in the system.

Multiplexor (Fig. 4)

The analogue input signal for each of the thirty channels is a plus or minus 10V full scale signal. The polarity is designated by toggle switch selection on the front panel of drawer one for each channel, individually. Under control of the multiplexor programming counter, matrix, and drive circuits, the analogue switch for each channel is turned on in sequence.

The 'on' channel is switched by means of diode action such that the input signal is present on the common multiplexor output bus attenuated by a factor of approximately 0·6. This output signal is applied to the offset circuits. Depending on the polarity sign a voltage offset is applied. A minus polarity sign causes zero volts to be added to the multiplexed analogue signal. The attenuated output is amplified by the operational amplifier and presented to the uni-polar analogue-to-digital convertor as a negative voltage, scaled to 5V full scale.

Conversely, a positive polarity sign causes a fixed negative voltage full scale offset signal to be linearly added to the positive multiplexor output signal. Hence, the resulting output voltage of the offset circuit becomes a negative voltage magnitude, equal to or less than full scale. Positive analogue input signals are thereby offset to a negative polarity which can be digitized, with the restriction that a zero voltage analogue input signal becomes the full scale value, and a full scale input analogue signal as seen by the unipolar analogue-to-digital convertor is expressed in nine's complement form when channel polarity is positive.

Programmer (Fig. 4)

The programming of the multiplexor is accomplished by a five stage binary counter, a diode matrix and associated logic and drive circuits.

The counter is initially reset by the control circuit, causing the multiplexor to switch channel *A* to the 'on' condition. Correspondingly, the front panel indicator light for this channel is turned on as a visual indication. On receipt of each advance pulse from the control circuit the counter is indexed to the next state, thereby advancing the multiplexor to the next channel. When the last channel is reached, a control flip-flop is set, conditioning the input gating of advance pulses to the counter such that the next advance pulse causes the counter to be reset to the initial state, channel *A*. Note that any channel 1 to 18 inclusive, can be selected as the last channel to be scanned, by means of the channel select switch. The binary counter output directly drives a diode matrix, through emitter-followers.

The thirty matrix outputs are adequately buffered to drive:

(a) Each multiplexor switch, total 30.

(b) Card sensor matrix, channels 1 to 18.

(c) Front panel indicator lights, total 30

(d) Channel *A* to *M* OR gates.

(e) Polarity select toggle switches, total 30.

(f) Channel select switch.

(g) Output channel identification, channels 1 to 18.

A common channel *A* to *M* drive level, present when-

ever the multiplexor stands on a channel between *A* and *M* is obtained. OR gates are used to sense the polarity sign of a given channel as selected by the front panel toggle switches. For channels 1 to 18 the polarity is compared logically with the corresponding polarity sign for the specific channel as read from the punched card in the card sensor. If the two values do not agree the sign error indicator light, front panel, gives notice to the operator that a system set-up error has occurred, either in the coding of the IBM punched card or in the toggle switch selection of polarity sign.

Operation

Two modes of operation are provided, selectable by mode toggle switch.

One mode is the normal operating mode of the system. An external START pulse (nominally, positive going 8V pulse, or greater, having a 1μsec rise-time, or better, and a duration greater than 1·5μsec) must be supplied to the system. If required, a START pulse may also be introduced manually by depressing the START push-button.

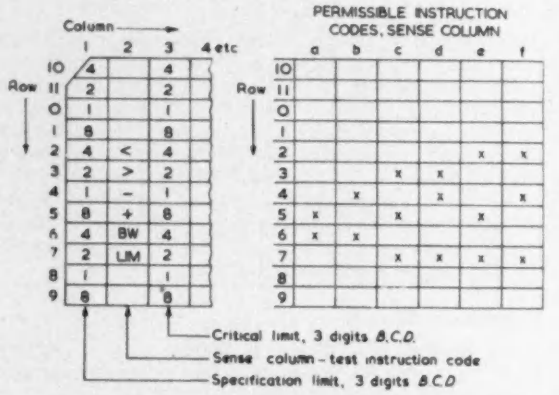

Column
1 2 3 4 etc
Row
10 11 0 1 2 3 4 5 6 7 8 9
4 2 1 8 4 2 1 8 4 2 1 8
< > − + BW LIM
PERMISSIBLE INSTRUCTION CODES, SENSE COLUMN
a b c d e f
Critical limit, 3 digits B.C.D.
Sense column - test instruction code
Specification limit, 3 digits B.C.D

Fig. 5. Representation of punch positions, standard IBM card, showing coding for channel 1, typical, to be used in digital transistor tester

x = *punched position*
a = *bandwidth test,* +
b = *bandwidth test,* −
c = *limit test, upper-upper* +
d = *limit test, upper-upper* −
e = *limit test, lower-lower* +
f = *limit test, lower-lower* −

The START pulse causes the multiplexor to reset to channel *A*. One complete scan is performed. When the last channel selected is reached the multiplexor is set to channel *A*, and the clock control flip-flop is reset to prevent further sampling. A second mode is provided for use in initially setting up the system and testing for faults. Associated with the test mode are three sub-modes of operation, namely, HOLD, SCAN, and CYCLE, selectable by means of the TEST selector switch.

Each time that a channel advance pulse occurs the clock control flip-flop is reset, inhibiting further action until a new command is received in the form of a push-button generated START, RELEASE, or INDEX pulse.

The scan is identical to the normal operate mode of operation in that one complete scan is performed after each START pulse. The cycle is identical with the scan mode, expecting that the system will continue to scan indefinitely until some other sub-mode is manually selected by the test select switch.

HOLD ALARM

This feature is associated with channels *A* to *M*, which are used for monitoring purposes. If a hold bit is generated by the GO/NO-GO logic it is used to set a flip-flop causing the clock control flip-flop to be reset to the off condition, halting all operations. At the same instant the alarm indicator, front panel, is turned on. This condition is remedied by a subsequent start pulse or by depression of the release push-button. If desired by the system operator, the hold feature can be over-ridden by placing the on-over-ride toggle switch in the over-ride position.

The functions of the three control push-buttons are summarized as follows:

START

This button is used to generate a start pulse, which causes the control circuit to be reset. The system then commences operation on channel *A*. This switch is operated in either OPERATE or TEST mode.

RELEASE

Operation of this push-button causes the clock control flip-flop to be set in the ON condition. This operation causes the hold flip-flop to be reset in either mode of system operation. The release push-button allows the operator to by-pass any channel, *A* to *M* on which a HOLD condition has occurred.

INDEX

The index push-button permits the operator to index the multiplexor one channel, since it generates, effectively, the multiplexor advance pulse.

COMPARATORS

The basic comparison performed results in a determination *X* greater than *A*, or *X* less than *A*, where *X* is the number obtained from the analogue to digital convertor and *A* is either limit, obtained from one of the shift registers. The digitized number and the limit numbers are expressed as three binary coded decimal digits. Comparison proceeds serially, bit by bit, from the most significant bit (m.s.b.) of the most significant digit (m.s.d.) to the least significant bit (l.s.b.) of least significant digit (l.s.d.). Results of comparison are stored in the respective flip-flops. As the two numbers are compared bit by bit, the logic circuit senses either condition; *X* greater than *A*, or *X* less than *A*. The condition which occurs and is detected first is stored in the respective flip-flops. Should *X* equal *A*, no decision is made. However, the flip-flop has been initially reset by clock time T_4 to the state *X* less than or equal to *A*.

IBM Punched Card

The method of coding the card is shown in Fig. 5. A punched hole in a given punch position assigns the value of weight shown, that is, a punched hole is equivalent to binary 1, no punch is equivalent to binary 0. With the card inserted in the card sensor, a switch is associated with each punch position. If the position has been punched, corresponding to binary 1, the switch is closed.

The associated card sensor output diode matrix circuit operates in principle as a collection of multi-element OR gates, 30 gates, 18 elements, −3V.

Acknowledgment

The authors acknowledge with thanks the contributions of Messrs. Kenneth R. Waters and Leslie Woods who carried out the difficult task of wiring and producing an operational system.

Low Impedance Capacitor Design

with Special Application to Filters

By C. W. McCutchen*, and I. D. Howard†

An investigation is described into methods of reducing the series inductance of conventional capacitors. The properties of the actual capacitive part of such capacitors are investigated and the knowledge gained leads to an improved method of connexion for filter capacitors which enables their losses to help in the filtration.

(Voir page 404 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 411)

ANY practical capacitor is really a complex circuit involving distributed capacitance, inductance, and resistance. In applications at moderate frequency it can usually be considered as a capacitance in series with a small inductance. In transmitting a.c. signals, which are generally at high impedance, the series inductance does little harm. Similarly, in *RC* and *LC* circuits, the capacitor inductance is usually unimportant provided the components are suitably chosen. In circuits for filtration, decoupling and current by-passing, however, this limitation is a problem for the designer, especially in wide-band apparatus.

A decoupling circuit usually consists of a high series impedance (an inductor or resistor) combined with a low impedance capacitive shunt to earth. Because the shunt has series inductance, its impedance, instead of falling monotonically with frequency, will fall and then rise again. At the same time, stray capacitances will lower the series impedance, so that at high frequencies the decoupling becomes ineffective. To obtain a filter without this failure at high frequency one would need either a pure inductance or a pure capacitance. Of these, the pure capacitance seems to be the more approachable.

The inductance/shunt capacitance ratio of an inductor, at constant d.c. resistance, is improved by increasing its linear dimensions, but this wastes space. Furthermore, large coils tend to produce unwanted magnetic coupling. Ferromagnetic cores increase inductance, but also shunt capacitance. This cannot be reduced by earthed electrostatic shielding between winding and core because this produces distributed capacitance between the winding and earth, which makes the inductor behave as a delay line.

Methods are already in use by which the series inductance of capacitors can easily be reduced by large factors. In the case of a tubular capacitor with end leads, most of the inductance lies in the flux linking the circuit completed by these leads. This is of the order of 50×10^{-9}H. The usual remedy has been to mount such a paper or electrolytic capacitor in a close fitting can. This makes the wire leads as short as possible and at the same time reduces the inductance of the capacitor body by reducing the space available for magnetic field. For a typical metallized capacitor (1μF 250V Hunts type W 48, A 309), this reduces the inductance by a factor of about 8.

This principle can be extended. If the capacitor is canned without being given its usual wax or resin casing, an even closer fit of the can to the actual capacitive element (hereafter referred to as the element) can be obtained, with the usual leads eliminated (Fig. 1). The element and the can now form a short length of low impedance transmission line. For use in a circuit the capacitor should be connected by extending the low impedance transmission line. Because this coaxial line is inconvenient the equivalent method shown in Fig. 2 has been developed which uses a flat transmission line of copper foils separated by a thin dielectric layer. The foils are bent round the capacitor element and each

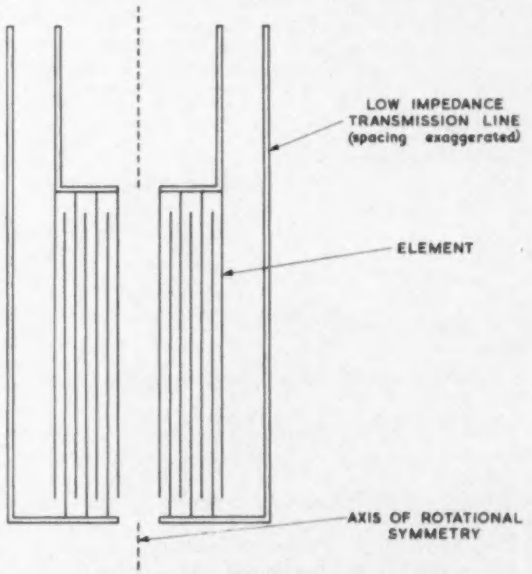


Fig. 1. Coaxial low inductance capacitor mounting

crimped round one end for soldering to the metallized terminal layers at the ends of the element. The drawing shows the foils wrapped around the element in opposite directions. Wrapping them in the same direction is electrically equivalent but the result is mechanically weaker. Double-sided Scotch tape of ·005in thickness has been successfully used as the dielectric, in conjunction with 1in wide copper foils of ·003in thickness. This makes a line of 1Ω impedance which is both easily constructed and durable. This tape line does not provide electrostatic shielding (unless, of course, one goes to the trouble of wrapping the earth tape around the live one) but in low impedance circuits electrostatic pick-up is far less important than electromagnetic pick-up. Here, due to the high reluctance of the long, narrow path between the tapes, mutual inductance to neighbouring circuits is so small that the line may be considered as being magnetically shielded. In order to discuss the performance of this type of capacitor the method must be described which was used for measuring capacitor properties, for these can no longer be described in terms of lumped constants.

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Measurement of Capacitor Characteristics

Use is made of a Garwin[1] type mercury switch pulser to switch (in less than 2×10^{-9}sec) a known and approximately constant current into the capacitor under test and then the voltage across the capacitor is observed with an oscilloscope. The pulser output is taken as shown in Fig. 3 by a 72Ω coaxial transmission line to a coaxial-to-tape adaptor. The tape transmission line leads to the capacitor under test. As near the capacitor as possible another coaxial-to-tape adaptor takes the output signal to a Tektronix 545 or Mullard sampling oscilloscope, model 362.

If the capacitor had zero inductance, the output would be simply a linear rise in potential. The presence of series inductance produces an initial spike, while if there is resistance as well, there will, in addition, be a constant IR component. Fig. 4 shows the most general waveform for a simple series RCL circuit. The inductance can be found from the area of the initial spike, for integrating

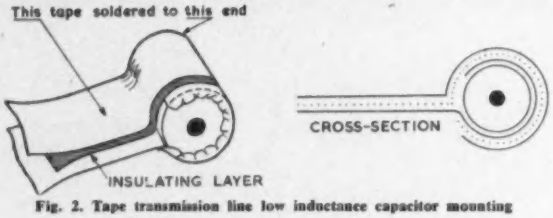

Fig. 2. Tape transmission line low inductance capacitor mounting

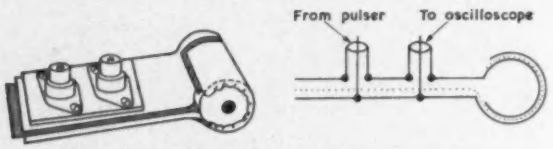

Fig. 3. Coaxial to tape line adaptor for capacitor testing

$V = L\,dI/dt$ shows that $LI = \int V dt$, the integral being taken over such time as is taken for constant current to be established in the inductance. In fact the high speed sampling oscilloscope shows the initial 'spike' to consist of a damped h.f. oscillation. Presumably the tape line and capacitor form a short transmission line with an inductive short-circuit at one end. This detail is not seen on the Tektronix 545 with its 25Mc/s bandwidth. However, the calculation of L is unaffected by these considerations as it can be shown that any linear and casual device (here the oscilloscope amplifier), though it may grossly distort the form of a short pulse, will preserve its area, provided only that the length of the pulse is short compared with the differentiating time of the device. Thus $\int V dt$ as measured on the oscilloscope will be correct even though pulse detail is lost. Measurement of this integral (the area of the pulse on the screen) will give the effective series inductance of the capacitor plus that of the tape as far as the oscilloscope lead junction. Calibration with loops of known inductance showed this method capable of giving ±20 per cent accuracy without any difficulty.

When the 1μF 250V Hunts metallized capacitor in the Fig. 3 mounting was tested, the waveform shown in Fig. 5 was observed. The most noticeable feature of the response is a stepped rise in voltage such as is found when a constant current is switched into an open-circuited transmission line. In fact, the capacitor element is a radial transmission line with capacitive loading. Currents in this line (hereafter called the element line) flow in the circular end plates in a radial direction and in the foils in a direction parallel to the axis of the element. The foils are resistive enough so that currents tend not to spiral along them but instead only travel across them to the end plates, in which they travel radially. Foil currents are thus local and the effect of the foils is much the same as filling the space between the circular ends with a strongly anistropic dielectric. Each annular element of an end plate has a large capacitance to the equivalent annulus on the other end plate, while the currents which charge this capacitance follow the cylindrical surface between the annuli. Because this line is radial, its Z_0 rises as $(\text{radius})^{-1}$ as one penetrates toward the centre. This accounts for the fact that the steps have rising rather than flat tops, for low frequency components will be partially

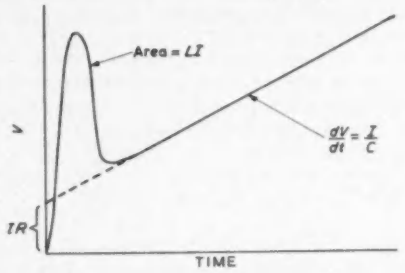

Fig. 4. Potential across series RCL circuit following application of a step function of current

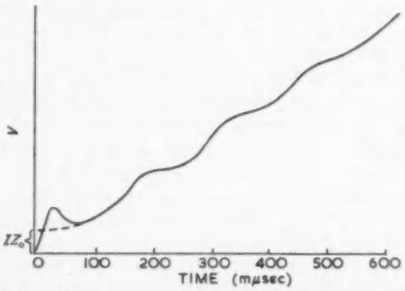

Fig. 5. Response of a 1μF Hunts Type W48 A309 metallized capacitor following application of a step function of current

reflected before they reach the far end. The input impedance of this line is about 0·08Ω and its natural frequency is 6·8Mc/s. Fig. 6 shows the configuration of potential, current and magnetic field at a time when the first voltage step has penetrated half way into the element. In this drawing the effect of the impedance taper has been neglected.

The lines of magnetic flux in such a line are approximately circular, while the foils spiral. Thus the foils are penetrated by the lines of flux, which change, and eddy current losses result. If the foils did not spiral the eddy current losses would be far smaller, for a component of field normal to the foils is enormously more effective in producing losses than an equal parallel component. Because of the high resistivity of the thin metallizing (0·5Ω per square) these losses are fairly small. A rough calculation suggests that they do not provide much of what damping is observed. It is this absence of eddy current loss which accounts for the 5 to 300Mc/s (depending on the capacitance) ringing for which metallized capacitors are noted.

At the beginning of the first step there is an inductive spike. Part of this inductance lies in the tape leads to the capacitor. This is easily verified by substituting for the capacitor a length of tape short-circuited at its end. The inductance of the tape thus measured is 10^{-10}H/cm. The remainder is associated with the capacitor element and the tape immediately shrouding it. This is about 5×10^{-10}H under the conditions of measurement. The resolution of the combined inductive spike from the resistive step was hindered by the slow (15mμsec) rise-time of the Tektronix 545 oscilloscope. The observed inductive spike tended to be masked by the fact that it sat on the rising part of the response to the resistive step. The solution to this was to compare the capacitor response with that produced by a shorted tape with some resistance intentionally introduced into the short. This resistance was varied until the observed response had the same shape as the inductive spike and first plateau of the capacitor response. At this condition the resistance/inductance ratio of the test circuit equalled the Z_0/inductance ratio of

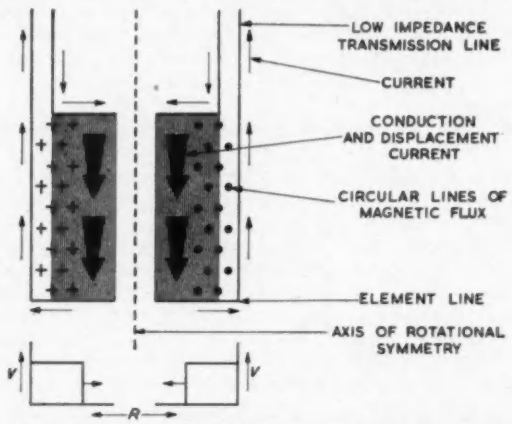

Fig. 6. Distribution of current, potential, and magnetic field in an element line at a time ½ ring period after the application of the current step
The effect of the impedance taper is ignored in this drawing

the capacitor. The resistance of the test circuit was determined from the equilibrium height of the resistive step observed on the oscilloscope, while the inductance was measured by removing the resistance from the short-circuit and then measuring the area of the inductive spike. Note that this method resolves the response into pure inductive and pure resistive components which is not very realistic.

One can best regard the capacitor and mounting as being made up of three transmission lines (Fig. 6). The element line is connected to the input line via a short length of line formed by the shrouding tape and the outer surface of the element. Exactly what happens in this short section is difficult to say, however it seems clear that skin depth effects in the relatively poorly conducting element line will raise the inductance. Certainly the measured inductance of this section is larger than would be expected from the spacing between the outermost foil of the element and the inner surface of the shrouding line. Such inductance as is produced by skin effect will be frequency dependent. It is for this reason that the measured inductance is, in the strictest sense, only a parameter of the response to the particular test signal. Since this test signal is quite representative of the signals which the capacitor is expected to handle, this inductive parameter is useful if somewhat impure.

It is probably better physics to treat this skin effect component of the inductance in terms of the characteristics of the element line. At some high frequency the wavelength in this line, as calculated from its distributed inductance and capacitance, will become comparable with the skin depth for currents in element material. Above this frequency the line characteristics, in particular the impedance seen at the input, will probably differ vastly from the low frequency values. No analysis has been done on this complex problem, however the impedance can only rise or fall and the results indicate that it rises. Further, because skin effect phenomena are dissipative, one might expect transmission by the element line to be strongly attenuated at these high frequencies. This surmise is confirmed by looking at the signal at the far (geometrically the inner) end of the element line. This can be done as shown in Fig. 7. In order to see high frequencies the Mullard sampling oscilloscope was used. When a current of 2A is switched into the capacitor, the 200Mc/s ring seen at the input (which makes up the inductive spike seen with the Tektronix 545) is invisible among the 0·05V base line wriggles of the oscilloscope. Further, the initial step of the staircase is much reduced in steepness. Because of open end reflection the step is

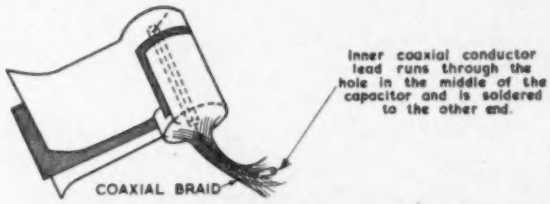
Inner coaxial conductor lead runs through the hole in the middle of the capacitor and is soldered to the other end.
COAXIAL BRAID

Fig. 7. Capacitor with connexions to both ends of the element line

twice as high as it is at the input end. Naturally, it occurs one half ring period later than the input step. Interestingly, at this end, the result of the impedance taper is to make the plateaux slope downward.

A 0·5μF, 350V extended foil capacitor (Hunts type L57, A 136) gave about the same results as metallized capacitors except that damping is much higher because of increased eddy current losses in the thicker foils. The inductive spike was 5×10^{-10}H, the impedance of the element line is 0·1Ω, and the ringing period is somewhat over 100mμsec though the very heavy damping of the ringing makes this latter determination rather vague. Rough calculation of the losses shows that the ringing should virtually cease in one cycle. In fact, only the first step of the staircase is visible, while at the far end of the element line (again using the Fig. 7 connexion) even that step is nearly unrecognizable. As with the metallized capacitors an unmeasurably small amount of h.f. ringing penetrates to the far end.

With capacitors which have mechanically strong foils one can connect the tapes directly to the foils. There is no advantage in doing this with metallized or extended foil capacitors because the h.f. circuits are equivalent to the Fig. 2 type. At the same time one introduces into the circuit the resistance of the unwound length of capacitor foil. With spiral foil electrolytics, on the other hand, this is the only means of low impedance connexion because, in these, the normal connexion is made to one point only on each foil. This was done with a 32μF spiral foil electrolytic (TCC type CE 94 PE) which had coiled electrodes 24in long, 1·9in wide, of aluminium foil with ·005in electrolyte-soaked spacers. The voltage waveform obtained when the constant current was applied by

a direct transmission line connexion is shown in Fig. 8. The 0·1Ω high frequency impedance and 30mμsec ringing period indicated that at these frequencies this capacitor acted as a 1·9in wide, ·005in spaced, lossy transmission line with the paste filling as dielectric, the resistivity of the electrolyte being too great for true electrolytic action to occur at high frequency. Whatever inductive spike there is, is masked by the response to the IZ_0 step. The curvature on the graph indicates the rise in the effective capacitance with lower frequency as true electrolytic action takes over. From the gradient, the effective capacitance at times 150, 300 and 600mμsec from the pulse edge was found to be of the order of 2, 4 and 8μF respectively (nominal capacitance 32μF).

Another form of mounting is used with the tantalum pellet electrolytic (Plessey Castanet type TA 25015, 250μF, 15V). It is simply put between the two tapes of a tape transmission line which is moulded down tightly around it to eliminate any room for magnetic flux. Here there is no noticeable ringing. There is a 5×10^{-10}H inductive

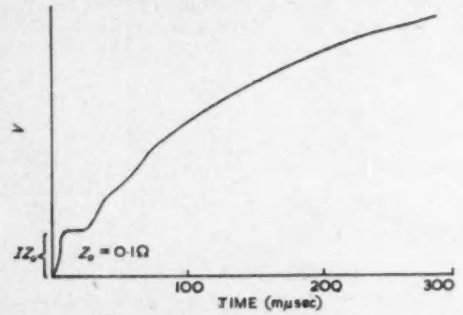

Fig. 8. Response of a 32μF TCC Type CE 94 PE spiral foil electrolytic capacitor following application of a step function of current

spike followed by a slowly decreasing rate of rise as the effective capacitance rises.

Use of Low Inductance Capacitors

Direct Use of Low Impedance

These capacitors can with advantage replace conventional canned mounts for cathode by-passing and similar service. Conventional valves and transistors have too much lead inductance to take full advantage of low inductance by-passing. Disk seal valves are much better, for connexion can be made in tape geometry all the way to the electrodes and a substantial increase in bandwidth of the by-passing should be possible.

Low inductance capacitors, combined with tape transmission lines make it possible to distribute h.t. at very low impedance. There are several advantages. The most important is that there is a great reduction in unwanted interaction between different circuits supplied by a common h.t. line. For example, a high gain amplifier built this way will be unlikely to have unwanted output-input coupling via the supply impedance. The same results are conventionally accomplished by decoupling, that is, by putting a filter between every circuit and the h.t. supply line. If there are many circuits this uses many more components than the low impedance method.

There are cases when decoupling will not work at all. It was one of these which started this low inductance capacitor project. A multi-output pulser with very little crosstalk between the different output channels was required. This might have been accomplished by extreme decoupling, however another requirement of the design was that the pulses be well standardized in height and very square. Decoupling would have resulted in l.f. variation in h.t. voltage and the squareness and standardization of the pulses would have suffered.

Filtration

It is helpful to think of the low impedance element in a filter as a four terminal network. What is required is that the input half and the output half influence each other as little as possible.

The mount shown in Fig. 2 is not ideal here because inevitably the tape impedance will be common to input and output. This is partially solved by the arrangement shown in Fig. 9(a). Here the only common impedance is that of the element transmission line and the short length of shrouding line, while the impedance presented to either input or output side is about the same as in the Fig. 2 mount. This four terminal connexion is easily

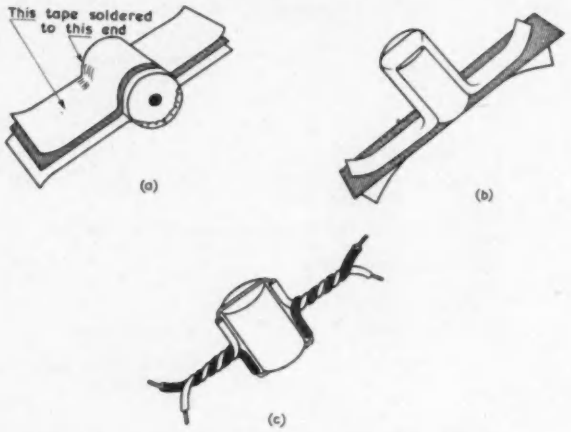

Fig. 9. Four terminal filter capacitor not using series element line connexions

used on the tantalum pellet electrolytic. The tape input and output effectively eliminates mutual inductance between the two circuits, though even close-spaced wires (preferably twisted) can be used if the single-ended low impedance is not required. The arrangements shown in Figs. 9(b) and 9(c) have an inductive coupling between input and output of $7{\cdot}5 \times 10^{-10}$H.

Where it is not required that the inductance be low as seen from either end it is attractive to take input and output from opposite ends of the element line as in Fig. 7 and let the line losses help with the filtration. From the discussion in the section on measurements one can see that the transmission of h.f. disturbance is very low with either the metallized or the extended foil capacitor. This is termed a series element line capacitor.

With the 1μF metallized capacitor the first-voltage step, when it arrives at the far end of the capacitor, has a maximum rate of rise $dV/dt = I/(2{\cdot}5 \times 10^{-7})$ where I is the applied current. At h.f. (10 to 200Mc/s) therefore the mutual impedance between input and output is what one would get with a 0·25μF pure capacitance. Since the output is delayed there are, of course, phase shifts not present with the pure capacitance. At lower frequency the mutual impedance drops to that of a 1μF capacitance. The 0·5μF extended foil capacitor is even better, for at h.f. it shows an apparent mutual capacitance of 0·33μF or two thirds its l.f. value. Fortunately the losses which do this job are only h.f. losses and do not increase the

d.c. resistance of the capacitor. This would not be true if one used this connexion on a capacitor whose foils were not all joined at each end. This objection does not hold in the case of a spiral foil electrolytic in which the tapes are short and conductive. Unfortunately, these same factors make the h.f. attenuation low as well, with the result that the 32μF TCC electrolytic, when connected in this manner, shows an h.f. response equivalent to only $4 \times 10^{-3}\mu$F.

If the full filtering ability of the series element line capacitor is to be exploited the output must be well shielded from the input. In Fig. 7 this shielding is provided by the outer conductor of the coaxial connexion, however any topologically similar shield is satisfactory. Prospective users must be warned that even a small imperfection in the shield will pass more disturbance than the actual connexion through the capacitor.

The ultimate in input-output shielding is lead-through construction. This can be done with a tape connected capacitor while preserving the low impedance simply by leading the live tape through a slot in the chassis. The possible ways in which series element line connected capacitors can be used in lead-through connexion are many and will not be pursued in this article.

Practical Aspects of Low Inductance Capacitor Construction

Obviously some of the procedures discussed are not practical for anyone other than the manufacturer himself. For example, an electrolytic capacitor with its can removed will not last long. In contrast, the home-mounted metallized capacitors have fairly satisfactory life if, after the connexions are made the assembly is dipped in melted hard wax so as to exclude moisture. The multi-channel pulser used 22 of these capacitors in Fig. 2 mounts and in several hundred hours of operation stretching over several months there were only four capacitor failures. The capacitors were run at 200V and were, as they should not have been, connected in parallel with 32μF electrolytics.

Future Prospects

Several improvements in filter capacitor design suggest themselves. A simple one for series element line filter capacitors (Fig. 7) would be to wind them on a larger mandrel to allow a low impedance connexion to be made to the inside. With metallized capacitors one could try to increase the damping. This would be done by arranging the foils so they are penetrated by more flux. One method would be to use a multi-start method of winding employing many more than the conventional two foils. This would make the foils spiral more sharply toward the centre and thus intercept more of the circular flux lines. Alternate foils would be connected to opposite ends as in present capacitors. A second method would be to wind the capacitor on a flat mandrel, thus getting an oval shaped result. One might expect that the flux and foils would intersect at substantial angles in some parts of such a capacitor. The same treatment could be applied to extended foil capacitors, however their damping is already so high that they hardly need it.

Use of the multi-start arrangement might be expected to raise the ringing frequency and lower the impedance by converting the element line into many short lines in parallel. This would be true if the foils were thick compared to the skin depth at the ringing frequency. As they are not, the principal effect will be to raise the damping, though at very high frequency this desirable reduction in impedance should occur with extended foil capacitors. To produce a paper capacitor of the true multiple-transmission-line-in-parallel-type which would retain this characteristic down to 10Mc/s one would have to use enough aluminium to more than double the total weight of the finished capacitor. The reason is as follows. This amount of aluminium is required to make thick enough foils to coerce the lines of magnetic flux into longer paths than in the ordinary loaded transmission line mode, and it is this lengthening of the magnetic circuit which reduces the impedance of the line or assembly of lines.

Acknowledgment

The authors wish to thank Messrs. A. H. Hunt Ltd for supplying them with unmounted capacitor elements. They wish also to thank the United Kingdom Atomic Energy Authority for financial support.

REFERENCE

1. GARWIN, R. L. A Pulse Generator for the Millimicrosecond Range. *Rev. Sci. Instrum. 21*, 903 (1950).

An Aircraft Load Control Computer

An electronic computer system for aircraft load control and passenger check-in has now been brought into operation by Scandinavian Airlines System at Kastrup airport, Copenhagen. Designed, manufactured and installed jointly by Standard Telephones and Cables Limited, London, and its associated Company, Elektrik Lorenz, Stuttgart, this system, which has cost about £100 000, has been designed to the special requirements of S.A.S.

For modern airlines it is important to know for each passenger, what weight of baggage he has, and where it is to be loaded in the aircraft. Knowing the number of passengers and their combined weights it is possible to obtain an overall picture of the total load to be carried by the aircraft and the distribution of this load. When these figures are available in time, the operating airline is able to use space capacity by loading and carrying revenue earning freight and/or mail. For this information to be of any value it must be speedily available at some given time before take-off. With a manual system, either the number of check-in points must be limited, or passengers must present themselves and their baggage an inordinately long time before take-off, otherwise a very expensive system of document handling must be introduced.

The new electronic computer system collects check-in data from all counters, computes and totals this data to provide the information needed for the compilation of aircraft load sheets, and prints out load sheets, load messages etc., for each destination of every flight departing from Kastrup.

The advantages of such a system are:—

(a) Freedom to check-in at any counter for any flight.

(b) Instantaneous collection of data from all check-in points.

(c) Flexibility of calculation so that the different requirements of different aircraft can be catered for by high speed computation of load data.

(d) Since there is no manual intervention between the actual check-in and the production of results, there is less chance of error.

(e) Results are available quickly, enabling a more economic loading of the aircraft (e.g. more freight can be carried).

(f) The system is capable of expansion and extension.

The equipment consists of the Stantec Zebra computer (providing the central control, the data storage and the necessary computational facilities) connected to input sets at the check-in counters, and master sets (for input and output) at Load Control.

The keysets at the check-in counters are similar in appearance to those already in use in the S.A.S. electronic seat availability system, but have facilities for keying in baggage weight and the various categories of passenger.

The master sets at Load Control, which are also push button devices, are used for the input of basic aircraft data, and the output (either on a visual display or a printer) of load status and seat status reports together with load sheets and load messages for onward transmission to each destination of the flight concerned.

Characteristics and Applications of Glow-Discharge Tubes

By F. A. Benson*, D.Eng., Ph.D., A.M.I.E.E., F.I.E.S.

(Part 1)

Recent work to determine the characteristics and limitations of glow-discharge tubes is reviewed. The effect of varying the argon content in neon-argon reference tubes, the use of krypton and xenon as admixtures and the characteristics of helium-neon and helium-argon gas mixtures are first discussed. The properties of monocrystalline, polycrystalline and activated cathodes are then described. Following sections deal with variations of gas pressure, temperature coefficient of running voltage, noise, ceramic-metal tubes, impedance characteristics and hollow-cathode tubes, sputtering, photo-electric effects, gas clean-up and several miscellaneous characteristics. Finally, some tube applications are mentioned.

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

THE cold-cathode glow-discharge tube has many applications in electronic circuits, but is particularly valuable as a simple voltage regulator and as a source of reference voltage in thermionic-valve stabilizers and elsewhere. The desirable characteristics of such tubes vary with the application. A great deal of work has been carried out during the last ten years on glow-discharge tubes. Many early investigations consisted of comparing performances of commercial stabilizer and reference tubes[1] and the following characteristics have been studied: running-voltage/current curves, initial drift, change of running voltage with temperature, impedance-frequency curves[2] and noise[3]. Later, tests were carried out on a number of special tubes with different cathode materials, gas fillings, gas pressures and constructions[4,5], to determine the effect of these tube parameters on the various characteristics. Some of the latest work in this field is reviewed below and the results of some recent measurements by the author are presented.

Gas Filling of Tubes

A small quantity of argon is usually added to the main gas filling of tubes to reduce the striking and running voltages and also to minimize the difference between these two voltages. Argon also facilitates sputtering when high-stability reference tube manufacturing techniques are used. The results obtained from many of the early investigations suggested that the argon content was an important parameter and this had not been kept constant in the various batches of tubes produced. Consequently more recent investigations were carried out on similar special tubes in which only the argon content was varied[6]. The tubes examined had cerium cathodes and helium and neon as the main gas fillings, the argon content being varied in steps of 0·5 per cent from zero to 3·5 per cent. Only a limited number of conclusions could be drawn from this work because of the large spread of results observed for tubes of a given type and by the fact that no impedance/frequency and noise characteristics could be obtained for neon tubes having more than 2·5 per cent of argon because of the presence of internal high-frequency oscillations. The running-voltage/current curves also exhibited voltage steps which increased in magnitude with the argon content. The disappointing results were thought to be due to non-uniformities of the cerium-coated cathode surfaces which were employed. A fuller study of the effect of varying the argon content in neon-argon filled tubes has since been made[7,8] with argon contents varying from 0·001 to 10 per cent. In this latest work molybdenum electrodes were used and high-stability reference-tube manufacturing techniques were employed in an attempt to obtain reliable characteristics.

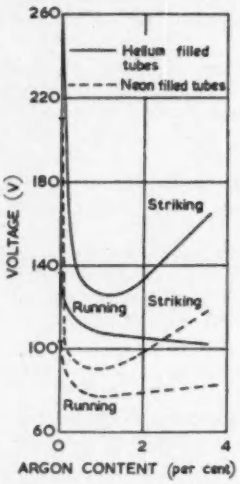

Fig. 1. Striking and running voltages as a function of argon content for cerium-cathode tubes
Running voltages recorded for a tube current of 20mA

Fig. 1 shows mean curves of variations in striking and running voltages with changes in argon content for cerium-cathode tubes. Very small additions of argon are seen to have a large effect on both voltages. Tubes with no argon exhibited a negative temperature coefficient of running voltage very much greater than those which had. With argon present the voltage changes with temperature were very small and the amount of argon used is not very important in this respect.

Fig. 2 illustrates the minimum running voltage as a function of argon content for tubes with molybdenum cathodes. The variation of full-glow current, which is a measure of the current density, is also shown. The results are seen to agree fairly well with those of Jurriaanse, Penning and Moubis[9] who used a different electrode geometry which could account for the shift between the two running-voltage curves. A minimum running voltage occurs at about 0·3 per cent argon and a minimum spread of results (as indicated by the short vertical lines in Fig. 2) was observed with this argon content. The results of run-

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ning-voltage/temperature measurements on these tubes are summarized in Fig. 3 which gives a plot of the average running-voltage change against argon content for the range 20 to 50°C. During the investigations a modified form of Jurriaanse's theory[10] was developed from which the decrease in voltage/temperature coefficient with increasing argon content can be explained. Curves have been published[8] showing (1) the variations of effective resistance and inductance of a tube with tube current and argon content at a frequency of 10kc/s, (2) impedance as a function of argon content for various frequencies between 1 and 30kc/s and (3) reactance-resistance loci. It has been found that the noise generated in a tube is a minimum using

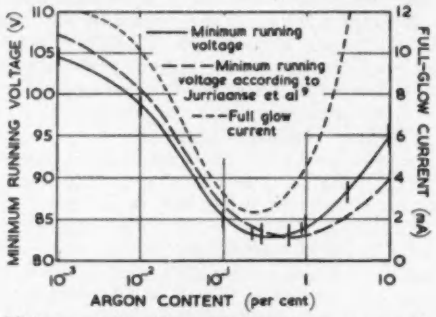

MINIMUM RUNNING VOLTAGE (V)
FULL-GLOW CURRENT (mA)
Minimum running voltage
Minimum running voltage according to Jurriaanse et al[9]
Full glow current
ARGON CONTENT (per cent)

Fig. 2. Minimum running voltage and full-glow current as a function of argon content for neon-filled molybdenum cathode tubes

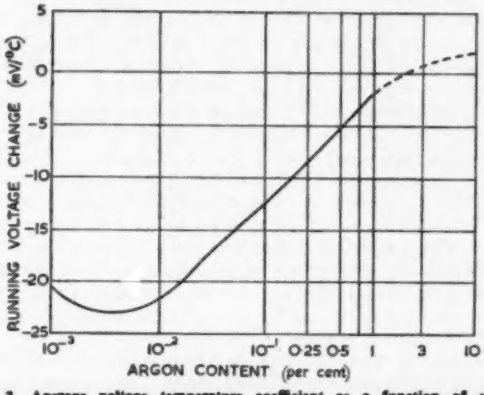


Fig. 3. Average voltage temperature coefficient as a function of argon content for neon-filled molybdenum cathode tubes

about 0·1 per cent argon, this corresponding to the region of minimum current density. Results suggest that the influence of argon content on tube life is negligible for contents greater than 0·01 per cent[8].

It has been concluded that the most desirable characteristics of neon tubes with molybdenum cathodes are obtained when the argon content is about 1 per cent. Minimum impedance and zero running-voltage/temperature coefficient, however, can be realized for argon contents lying between 1 per cent and 3 per cent, but it is difficult to prepare tubes which have similar and reproducible characteristics when the argon exceeds 1 per cent.

Other information on tubes containing neon-argon mixtures has been given by Frouws[11] and Kruithof[12] and Penning[12,13]. Frouws has made striking-voltage measurements on tubes with a fixed electrode distance, only the gas pressure and gas mixture being varied. The first series of measurements was carried out with molybdenum electrodes and (a) pure neon, (b) pure argon, (c) various neon-argon mixtures in the range 10^{-4} to 10 per cent argon. Additional measurements were made using iron electrodes.

Similar studies to those by Benson and Chalmers[7,8] have recently been made using neon-krypton, neon-xenon, neon-argon-krypton and neon-argon-xenon gas mixtures. It has been shown that krypton and xenon can be used successfully as admixtures in commercial neon glow-discharge reference tubes instead of argon. One particular advantage of using the alternative gases is that tubes can be manufactured which have different running voltages, but which otherwise have very similar characteristics. For example, a tube containing neon-0·1 per cent xenon has almost identical characteristics to those of a tube containing neon-0·3 per cent argon except for a small increase in generated noise, which is not very important, and a much larger minimum running voltage, i.e. 97·3V compared with 83·7V. If small amounts of argon and krypton or argon and xenon are added to a pure-neon tube then the tube behaves as if only one admixture was present, except when the percentages of the two are comparable, when certain desirable characteristics are obtainable, e.g. low impedance. The results of this work will be fully discussed in a forthcoming paper[14].

Weston[15] has determined the maintaining and breakdown potentials for a number of helium-neon gas mixtures over a pressure × distance (*pd*) range of 1 to 75cm mm of mercury. The normal cathode fall and the minimum breakdown potential were found to be higher for mixtures containing from 1 to 5 per cent neon, than for either of the pure gases. At higher *pd* values the breakdown potential was lower for mixtures of the order 50 per cent helium-50 per cent neon than for the pure gases. These results suggest reactions between the two gases affecting the ionization coefficients. Weston employed parallel-plate electrodes for his studies. These were in the form of molybdenum disks 0·5mm thick and 15mm diameter. In some tubes the electrode separation was fixed at 3 to 5mm, but in others one electrode was arranged to slide perpendicular to its plane. Weston discusses his results in the light of the work of Oskam[16,17] who has studied the decay of electron densities in the afterglow of similar gas mixtures. Another interesting paper by Oskam on tubes with very small percentages of neon in helium has been published elsewhere[18].

The running voltages and striking voltages in a number of helium-argon mixtures have been measured by Weston[19]. Tubes with parallel-plane disk electrodes of molybdenum were used. The mixtures show the Penning effect resulting from the ionization of argon atoms by helium metastables. Weston has plotted Paschen curves for the tubes and these are similar to those for neon-argon mixtures. Argon contents of 0, 0·001, 0·01, 0·1, 0·5, 1, 5, 30 and 100 per cent were used during the investigations and the normal cathode falls for the various mixtures at a pressure of 40mm of mercury have been listed.

Cathodes

Ahsmann and van Gelder[20,21] have studied glow discharges in tubes with single-crystal cathodes and have shown that very stable values of normal cathode fall can be obtained in this way. The cathodes used were disks with a diameter of either 23 or 18mm which were smoothly polished and appropriately etched. To prevent damage to the crystal structure the cathodes were not mounted by welding but each was pressed on a quartz cylinder by molybdenum springs. The anodes were mounted inside the quartz cylinders. The tubes were prepared by the well-known reference-tube sputtering technique. Values for the normal cathode fall in neon at a pressure of 40mm of mercury for germanium, silicon and copper and for

various crystal orientations have been published. For most crystals the running voltage depends on the orientation of the crystal face. Some crystal faces, such as the (100) face of germanium are unstable and become roughened by the discharge; it appears that there is a tendency for another crystal face to be exposed by sputtering, probably the (111) face. Preferential etching of metal single crystals after sputtering has also been reported by Wehner[22]. Spontaneous voltage jumps are not observed with monocrystalline cathodes. The most reproducible results were obtained with copper (111) faces. If a tube with such a face as cathode is kept at constant temperature in an oil bath and at constant current, the voltage drift is less than one part in 10^5 over a period of several hours. This stability is considerably better than that obtainable with polycrystalline cathodes.

The author has observed that with normal reference tubes variations in running voltage of about 1V at a given current occur if the cathodes are fabricated from molybdenum-sheet samples from different manufacturers. An attempt has been made recently therefore to show the connexion, if any, between the running-voltage/current characteristics of tubes, the grain sizes of the cathode materials and the surface roughnesses of the cathode. The tubes used had gas fillings of pure neon, neon plus 0·1 per cent argon and neon plus 1 per cent argon. All the other tube parameters were kept as constant as possible. Three tubes were mounted on one stem as shown in Fig. 4, so that the gas content and pressure were the same for each. It was also felt that any impurities released from the glass walls would probably spread fairly evenly throughout the three tubes. Seven different types of molybdenum were acquired, so several sets of tubes were constructed. Since the impurities and gas content would vary between the different sets of tubes, one type of molybdenum was put in each set, acting as a reference. It was then hoped that variations in the characteristics of the tubes would be largely due to the differences between the molybdenum samples. Running-voltage/current characteristics were recorded and the cathodes were then removed from the tubes for examination. The surface roughness of each cathode was determined with a 'Talysurf' instrument. Specimens of each cathode were mounted, polished and etched and then examined under a microscope. It was concluded from this work that there is no obvious correlation between running voltage, grain size and surface finish. However, it may be that variations in running voltage due to changes of the cathode material grain size and roughness are so small that they are masked by variations due to some other cause, probably impurities.

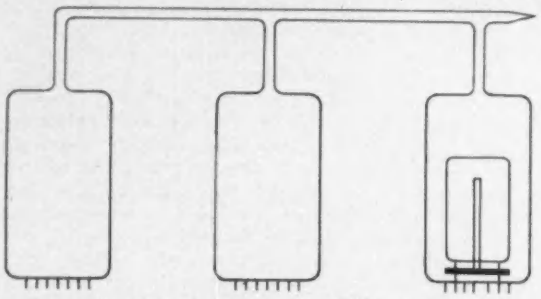


Fig. 4. Special tube construction for experiments on cathodes

A good deal of information is available on the crystallographic properties of molybdenum[23]. Cold rolling of molybdenum sheet brings the (100) planes into the plane of the sheet with the [011] direction parallel to the rolling direction, although there are some deviations from this rule. It is also of interest to note that cross-rolled molybdenum recrystallized at a temperature of 1 180°C for 10 minutes retains only the (100) [110] orientation. Recrystallization at a temperature of 1 280°C results in coarse grains of random orientation.

The author has recently made a detailed study of the effects of varying the electrode geometry of glow-discharge tubes on their characteristics. The results of this investigation will be published in a forthcoming paper.

One of the major developments in glow-discharge tubes has been the design of electrodes which will give reliable performance over long periods and will operate at lower voltages than are possible with plain metal cathodes. This has been achieved by coating the surface of the cathode with materials known as 'activators'. Dagger[24] describes the general principles involved in the use of activators and gives details of various methods used in present-day valve manufacture to produce satisfactory electrodes. Barium and potassium are suitable materials to use as cathode activators by virtue of their low work function and minimum running voltage. The difficulty with using these and similar materials, however, is that they have a great affinity for the atmospheric gases, oxygen, nitrogen, carbon-dioxide, etc., so special techniques have to be devised to obtain barium or potassium in a pure form on the cathode surface. One such technique, which is described in detail by Dagger, is to coat the cathode with a compound of barium or potassium and nitrogen, barium or potassium azide. An alternative method to the azide technique is to evaporate barium from an iron-clad barium getter flag on to the cathode. The flag is mounted just above the cathode and the barium is evaporated by radio-frequency induction heating after the valve has been exhausted. A similar method can be used for potassium, but a more effective technique is to distil the metal on to the cathode as explained by Dagger.

Potassium-activated cathodes have been described previously[1,25,26,27]. One disadvantage of using potassium is that it reacts with lead- or soda-glass envelopes, so special potassium-resisting-glass envelopes are used which adds considerably to the cost of the tubes. Another disadvantage is that because the melting point of potassium is low (62°C) the sputtering rate of the cathode coating is high and this largely governs the tube life.

Some of the features of oxide-coated cathodes are also described by Dagger[24]. The oxide coatings are usually prepared by spraying barium-strontium carbonate to a thickness equivalent to 1 to 3mg/cm^2 on to a specially prepared nickel cathode. The cathode is then heated by radio-frequency induction to a temperature of about 900°C when the carbonates are converted to oxides. A special activation process is then applied.

Pope[28] has outlined the general properties of lithium and explains why the characteristics of this material make it suitable for cold-cathode activation. He gives details of practical devices incorporating lithium-activated cathodes and compares them with similar devices using barium. Experimental results are given and discussed for the characteristics of lithium-activated electrodes in argon and neon-argon mixtures.

The effect of a glow discharge on an oxide-coated cathode has been investigated by Imai and Mizushima[29] and methods of preparing a suitable cathode surface for practical use have been described by them.

Gas Pressure and Temperature Coefficient of Running Voltage

An investigation of the effects of gas-pressure variations on the characteristics of the RCA 5651 tube has been

made by Blair[29]. The pressure was varied from 25 to 65mm of mercury in steps of 10mm and the gas mixture was 99 per cent neon and 1 per cent argon. He recorded striking voltage, running voltages at currents of 1·5 and 3·5mA, regulation, voltage jumps and initial drifts and examined the repeatability and life characteristics. One hundred tubes were made for the study. It is concluded that the best pressure to use for the tube is 52mm of mercury and should be held to a tolerance of ±3mm.

The temperature coefficient of running voltage of a glow-discharge tube has been shown[7] to be proportional to the slope of the running-voltage/pressure curve. Work is being undertaken at present by the author to determine the forms of the equations for the running-voltage/pressure curves of tubes for various gas mixtures so that changes in running voltage can be estimated even for large temperature variations. A little information on this topic is available in a paper by Jurriaanse[19]. He plotted

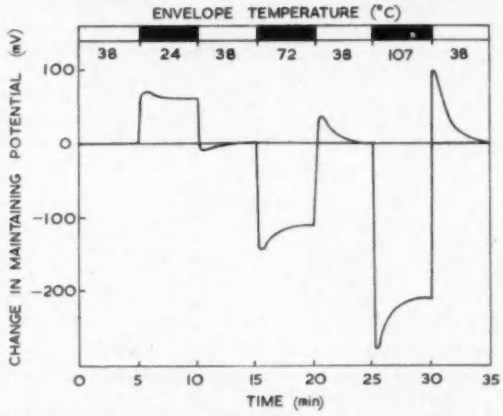


Fig. 5. Effect of changes in envelope temperature on maintaining potential for a type 85A2 tube

running-voltage/pressure curves for pure-neon and running-voltage/current curves for different pressures in the case of pure neon. He carried out similar but less extensive experiments for pure argon and neon plus 0·5 per cent argon mixtures.

Smith[31] has pointed out that elevated temperatures cause drifting of the running voltage in some tubes and that recorded changes of running voltage may not be due to temperature only, but also to the length of time held at that temperature. He has carried out some tests where the tube is normally held in a reference oil bath at 35°C. It was then plunged into one of six baths each held at a constant temperature covering the range 20 to 110°C. Running-voltage variations were continuously recorded. After five minutes the tube was returned to the 35°C bath and allowed to return to the reference state. Several commercial tubes were measured by this method. The manner in which the running voltage reaches its equilibrium value on suddenly increasing the temperature of the outside of the envelope is of interest. For most tubes an initial rapid decrease of running voltage is followed by a slow increase. A typical result for a type 85A2 tube at 5·5mA is shown in Fig. 5.

The effects of abrupt changes in ambient temperature on trigger breakdown voltage of trigger tubes has been briefly mentioned in a paper by Tosswill, Weston and Smith[32].

Noise Characteristics

Measurements on several types of commercial tube have shown[33-35] that noise characteristics of all tubes, at any stage in their life, follow the same general form; that is, the noise increases with decreasing tube current. Noise increases rapidly as the region of minimum current is approached. The effects of varying the cathode material, the gas-filling and the gas pressure on noise characteristics have been determined[36]. It has been found that helium-filled tubes give more noise than neon-filled ones, with the same cathode material. Gas-pressure variations from 30 to 50mm of mercury have little effect in determining noise characteristics, but cathode material is a very important parameter in determining noise performance.

Reed and Dix[37] have made spectral noise measurements on 85A2 reference tubes in the frequency band 20c/s to 10Mc/s and have attempted to correlate the noise properties with the measured impedance Z of the tube. To this end the tube has been represented by (a) a zero-impedance noise-voltage generator of e.m.f. e in series with Z and (b) an infinite-impedance noise-current generator with short-circuit current i in parallel with Z. The values of e and i were computed from the r.m.s. noise voltage measured across a known load. The following conclusions were reached:

(1) e increases as the mean tube current is reduced.

(2) At frequencies below 1kc/s, i decreases as the mean tube current is increased, but above 1kc/s i increases with tube current.

(3) Above about 2Mc/s, i is of the same order as the shot-noise current of a saturated diode with the same space current.

(4) For the higher tube currents e is approximately constant up to about 500kc/s.

(5) Tube impedance decreases with current at all frequencies and a marked resonance occurs at about 500kc/s.

These measurements were spread over a three-year period and during this time no significant change in tube noise with life was observed.

The results of a series of measurements of the admittance and the noise of OA3 tubes over a frequency range of 1c/s to 30Mc/s have been presented by van der Ziel and Chenette[38]. It is shown that the noise resistance of the tube is relatively constant below 1Mc/s and that the equivalent saturated-diode current of the tube is relatively constant above 1Mc/s. Theoretical treatments are given which explain most of the experimental results.

Noise picked up by current-carrying probes in gas-discharge tubes has been measured in the frequency range 0·5 to 30Mc/s by Galbraith and van der Ziel[39].

A note on noise measurements made on oxide-cathode discharges in krypton at pressures between 0·01 and 1mm of mercury and at discharge currents between 6 and 140mA has been published by Zaitsev, Vasil'eva and Mnev[40].

Ceramic-Metal Tubes

Lafferty[41] has developed a new process for making clean gas-discharge tubes for operation in critical environments. The tubes have very constant and reproducible characteristics and can be operated at temperatures up to 500°C.

Tube assemblies of ceramic and titanium are outgassed and then sealed together in an atmosphere of the gas with which they are to be filled. Hot titanium has a gettering action which gives a very pure gas filling and the high temperatures used in manufacture reduce the likelihood of gases being evolved from tube parts during life and contaminating the gas filling or cathode surface. The gettering properties of titanium have been studied by Stout and Gibbons[42] and discussed by Stow[43]. To make titanium-tube

envelopes, a series of ceramics was developed which could be sealed directly to the titanium.

Lafferty[41] has described several types of gas-discharge tubes made by this process. A voltage-regulator tube of simple construction, shown in Fig. 6, is one of the examples. A stainless-steel wire, coated with barium aluminide, is press-fitted into a titanium disk forming the tube base. A ceramic washer, undercut to form a long internal leakage path, separates the anode from the titanium envelope which serves as the cathode. On heating the structure to 1 070°C the seals are made, the barium aluminide dissociates evaporating barium uniformly on to the cathode surface and the anode is brazed to the titanium by alloying between the titanium and the stainless steel. Normal welding-grade argon is used for filling the tube, but this is purified by the hot titanium. Exceptionally flat running-voltage/current curves have been observed for these tubes, a typical one being shown in Fig. 6 with the characteristic of a glass tube for comparison. The characteristics from tube to tube are reported to be very reproducible.

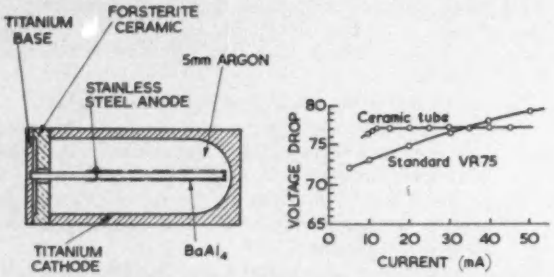


Fig. 6. Construction and characteristic of ceramic-metal voltage regulator tube

Lafferty[41] has also pointed out that combinations of titanium (cathode material) and xenon (gas-filling) give a cathode fall of about 160V and he has used these materials to produce a high-voltage tube where several cells operate in cascade. A parallel-plane electrode geometry is used and 2kV/in of tube length has been obtained.

Culp and Koskos[44] have constructed a voltage reference tube entirely of ceramic and metal. It has a running voltage of about 85V. An exploded view of the tube is shown in Fig. 7. The inner surface of the cup-shaped molybdenum envelope, at the left, serves as a cathode. The molybdenum rod at the right is the anode. The ceramic button, centre, insulates the two electrodes while supporting both and completes the envelope.

An interesting paper on metal-ceramic seals has been produced by Marsden* of the National Bureau of Standards. The purpose of the paper is to describe the various seals that are used or have been investigated and to point out the lack of fundamental information about the processes involved. The art of bonding metal and ceramic into a mechanically strong and vacuum-tight entity is barely more than a decade old. The basic work of this development was performed by the Germans during the war years. It was soon realized that the technique was specially adaptable to the production of a vacuum-tight electron device and its application has spread widely since about 1950. Many advantages accrue from the use of the technique largely due to the substitution of ceramics for glass and baking-out at higher temperatures.

Marsden first describes the original German molybdenum process involving the application of powdered molybdenum with or without powdered iron to the ceramic surface and bonding it thereto at a firing temperature above 1 200°C. This metallized surface is then covered by electroplating or other means with a copper or preferably nickel layer to decrease the probability of the destruction of the metallizing layer due to further alloying with the braze metal. A subsequent improvement involves the substitution of manganese as oxide or powder instead of the iron and it has been shown that the manganese probably does enhance the metallizing bond because of its ready diffusion into the ceramic body. Further improvements have been of questionable value, specifically one which involves the use of titanium powder or hydride with the molybdenum to enhance the bond.

The active-metal processes developed at the General Electric Company Laboratories in Schenectady have concerned the use of solid titanium or its hydride. In either case the titanium dissolves into the brazing metal, diffuses into the ceramic surface and develops ample bond. Other approaches have been developed in which the titanium is clad with the brazing alloy, or alloys of titanium which have low-melting eutectic points are used. A possible disadvantage of the titanium or so-called active-metal seals is that they require vacuum or extremely non-oxidizing atmospheres to develop the maximum bond. One of their big advantages is that they are a one-step process.

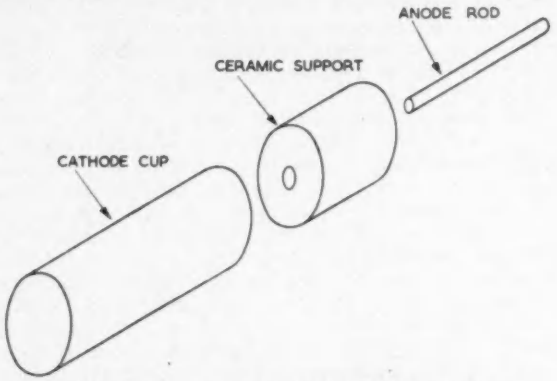


Fig. 7. Construction of ceramic-metal tube of Culp and Koskos

The metal-ceramic sealing technique has been limited to a few ceramics of which the demand for alumina far outstrips all others. The analysis of these aluminas varies from 85 per cent to 99 per cent, but again the highest demand is for the 95 per cent alumina body. The balance of the analysis is made up of other oxides such as magnesia, alumina or silica which form low-melting or sintered phases with the alumina oxide and give it desirable strength. The need for these bonding oxides decreases as the density increases or more properly as the pressure applied during pressing, increases. As these pressed bodies approach the theoretical density of alumina, the porosity decreases and the need for these bonding oxides also decreases.

Forsterite is the other ceramic which is next in demand. The advantages of forsterite, while it does have less strength, are that it is cheaper to prepare and cheaper to grind to dimensional tolerances.

Other ceramic bodies such as steatite, zirconite, magnesia, berrylia, etc., are all adaptable to these processes and have their particular advantages. The use of these has been confined to a few specific cases where their advantages

* *Private communication from the author. The paper has not been published.*

outweigh the disadvantages of a special material. Further, the art of densifying these oxides to attain vacuum tightness has not been developed as well as for the other two ceramic bodies.

The primary requirement in designing ceramics for a given application is to have tolerances on the piece as wide as possible, and where tolerances are essential the design should be easily adaptable to simple grinding operations. Obviously grinding is the only means, to date, of producing ceramics to close tolerances, mainly because of the high firing shrinkage in transforming the ceramics from the pressed condition of compacted individual oxide particles into a ceramic body. These firing shrinkages range from 10 to 20 per cent. Centreless and face-grinding of surfaces are the most easily accomplished. Internal grinding becomes extremely difficult especially when maintaining a dimension.

The metals to be bonded to a ceramic will be limited to those that have about the same thermal coefficient of linear expansion. The titanium and molybdenum processes are so far the only ones with successful applications. Elements with characteristics similar to these two metals should be capable of promoting a bond, but actually zirconium is the only other one which has shown any degree of success.

Ceramic-to-metal seals have also been described recently by D'Altroy and Pondy[45].

REFERENCES

1. Benson, F. A. Voltage Stabilized Supplies. (MacDonald 1956).
2. Benson, F. A., Mayo, G. Impedance-Frequency Variations of Glow-Discharge Voltage-Regulator Tubes. *Electronic Engng. 26*, 206 (1954).
   Benson, F. A., Mayo, G. Impedance-Frequency Characteristics of some Glow-Discharge Tubes. *Electronic Engng. 28*, 124 (1956).
3. Bache, H., Benson, F. A. Mean-Noise Characteristics of Glow-Discharge Voltage-Regulator Tubes. *Electronic Engng. 24* 328 (1952).
4. Benson, F. A., Bental, L. J. Glow-Discharge Stabilizers. *Wireless Engr. 32*, 330 (1955).
   Benson, F. A., Bental, L. J. Glow-Discharge Tubes. *Wireless Engr. 33*, 33 (1956).
5. Benson, F. A. Gas-Filled Voltage Stabilizers. *Elect. Radio Engr. 34*, 16 (1957).
6. Benson, F. A., Gillespie, E. F. F. Influence of Argon Content on the Characteristics of Glow-Discharge Tubes. *Proc. Instn. Elect. Engrs. 104B*, 498 (1957).
7. Benson, F. A., Chalmers, P. M. Effects of Argon Content on the Characteristics of Neon-Argon Glow-Discharge Reference Tubes. *Proc. Instn. Elect. Engrs. 106C*, 92 (1959).
8. Benson, F. A., Chalmers, P. M. Effects of Argon Content on the Characteristics of Glow-Discharge Tubes. *Electronic Engng. 32*, 218 (1960).
9. Jurriaanse, T., Penning, F. M., Moubis, J. H. A. The Normal Cathode Fall for Molybdenum and Zirconium in the Rare Gases. *Philips Res. Rep. 1*, 225 (1946).
10. Jurriaanse, T. The Influence of Gas Density and Temperature on the Normal Cathode Fall of a Gas Discharge in Rare Gases. *Philips Res. Rep. 1*, 407 (1946).
11. Frouws, S. M. Paschen Curves in Neon-Argon Mixtures. *Proceedings of the Third International Conference on Ionization Phenomena in Gases, Venice.* 341 (1957).
12. Kruithof, A. A., Penning, F. M. Townsend Ionization Coefficient for Neon-Argon Mixtures. *Physica 4*, 430 (1937).
13. Penning, F. M. The Starting Potential of the Glow Discharge in Neon-Argon Mixtures between Large Parallel Plates. *Physica 1*, 1028 (1934).
14. Benson, F. A., Burdett, G. P. Comparison of Argon, Krypton and Xenon as Admixtures in Neon Glow-Discharge Reference Tubes. (To be published.)
15. Weston, G. F. Glow-Discharge Characteristics of Helium-Neon Mixtures. *Brit. J. Appl. Phys. 19*, 523 (1959).
16. Oskam, H. J. Thesis (University of Utrecht, November, 1957).
17. Oskam, H. J. Microwave Investigation of Disintegrating Gaseous Discharge Plasmas. *Philips Res. Rep. 13*, 335, 401 (1958).
18. Oskam, H. J. Showing the Presence of Very Small Percentages of Neon in Helium. *Philips Res. Rep. 14*, 98 (1959).
19. Weston, G. F. Glow-Discharge Characteristics of Helium-Argon Mixtures. *Brit. J. Appl. Phys. 11*, 305 (1960).
20. Ahsmann, G. J. M., van Gelder, Z. The Normal Cathode Fall on Single Crystal Cathodes. *Proc. Fourth International Conference on Ionization Phenomena in Gases, Uppsala, Sweden.* ID.266 (1959).
21. Ahsmann, G. J. M., van Gelder, Z. La chute cathodique normale pour des cathodes monocristallines. *Le Vide. 15*, 226 (1960).
22. Wehner, G. K. Sputtering of Metal Single Crystals by Ion Bombardment. *J. Appl. Phys. 26*, 1056 (1955).
23. Northcott, L. Molybdenum—Metallurgy of the Rarer Metals—5. sec. 3. 5 (Butterworths, 1956).
24. Dagger, A. Cold-Cathode Valves, Part 1—The Preparation of Satisfactory Electrode Surfaces. *Siemen's Edison Swan Engng. Bul.* No. 277, 1 (1957).
25. Chilcot, A. L., Heymann, F. G. Potassium-Activated Cold-Cathode Tubes. *J. Sci. Instrum. 26*, 289 (1949).
26. German Cold-Cathode Tubes made by Siemens Reiniger Werke, Rudolstadt, Combined Intelligence Objectives Sub-Committee Report, Item No. 9, File No. XXXI—50, H.M.S.O.
27. Investigation of Cold-Cathode Tubes made by Siemens Reiniger Werke, Rudolstadt, Part 2. Production Details, British Intelligence Objectives Sub-Committee Report No. 622, Item 9, H.M.S.O.
28. Pope, G. C. Cold Cathode Valves, Part 2—The Use of Lithium as a Cold Cathode Activator. *Siemens Edison Swan Engng. Bul.* No. 277, 7 (1957).
29. Imai, T., Mizushima, N. Oxide-Coated Cathode for Cold-Cathode Discharge Tubes. *Rep. Elect. Commun. Lab. Japan 5*, 10 (1957).
30. Blair, S. T. Investigation of the Effects of Gas Pressure Variations on the Characteristics of the R.C.A. 5651. (R.C.A. Report, 1957.)
31. Smith, J. Temperature Coefficient of Maintenance Potential of Glow-Discharge Voltage Stabilizer and Regulator Tubes. *Brit. J. Appl. Phys. 9*, 122 (1958).
32. Tosswill, C. H., Weston, G. F., Smith, J. Second-Order Variations in Glow-Discharge Switching Devices. *Proc. Third International Conference on Ionization Phenomena in Gases, Venice.* 1105 (1957).
33. Bache, H., Benson, F. A. Peak-Noise Characteristics of Glow-Discharge Voltage-Regulator Tubes. *Electronic Engng. 24*, 278 (1952).
34. Bache, H., Benson, F. A. Peak-Noise Characteristics of Some Glow-Discharge Tubes. *J. Sci. Instrum. 30*, 124 (1953).
35. Bache, H., Benson, F. A. Mean-Noise Characteristics of Glow-Discharge Voltage-Regulator Tubes. *Electronic Engng. 24*, 328 (1952).
36. Benson, F. A. Gas-Filled Voltage Stabilizers. *Elect. Radio Engr. 34*, 16 (1957).
37. Reed, K. B., Dix, J. F. Gas-Filled Voltage Stabilizers. *Elect. Radio Engr. 34*, 113 (1957).
38. Van der Ziel, A., Chennette, E. R. Noise and Impedance Measurements in Voltage Regulator Tubes. *Physica. 23*, 943 (1957).
39. Galbraith, A. R., van der Ziel, A. Noise in Gas Discharges. *Proc. Fourth International Conference on Ionization Phenomena in Gases, Uppsala, Sweden*, IIA, 279 (1959).
40. Zaitsev, A. A., Vasil'eva, M. Y., Mnev, V. N. Possibility of Determining the Potential Distribution of a Plasma from the Characteristics of the Noise Generated in a Gaseous Discharge. *Zh. Eksp. Teor Fis. 36*, 1589 (1959).
41. Lafferty, J. M. A Process for Making Clean Gas-Discharge Tubes. *I.R.E. Trans. Electron Devices.* ED-5, 143 (1958).
42. Stout, V. L., Gibbons, M. D. Gettering of Gas by Titanium. *J. Appl. Phys. 26*, 1488 (1955).
43. Stow, R. L. Titanium as a Gettering Material. *Nature Lond. 184*, 542 (1959).
44. Culp, J. W., Koskos, P. A Ceramic-Metal Voltage Reference Tube. *I.R.E. Trans. Electron Devices*, ED-4, 144 (1957).
    Culp, J. W., Koskos, P. *The Sylvania Technologist. 9*, 1 (1956).
45. U.S.A. Patent 2,913,077 (1959).

(To be continued)

A Shaft Position Coder

George Kelk Ltd of Ontario have recently produced a shaft position coder. This is an analogue-to-digital convertor which accepts a shaft rotation input and delivers electrical outputs which express the instantaneous angular position of the input shaft in decimal circuit form. The digital information can be used to operate digital indicators, relays, printers or other external devices. The instrument has been designed for durability and maximum reliability of operation under very severe conditions such as those encountered in steel mill applications. Solid-state circuits and plug-in printed boards are used throughout.

An important feature of the convertor is the use of magnetic circuits for switching. This reduces friction and wear and eliminates the maintenance and operational problems usually associated with equipment incorporating contacts or light-path arrangements.

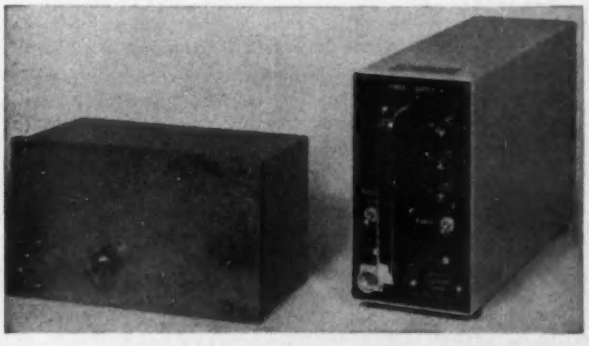
The output circuit consists of four decades of 10 circuits each. Any number from 0000 to 9999 can therefore be represented by the presence of a voltage at the appropriate circuit position of each of the four decades.

The design is such that only one output per decade is possible at any time and ambiguity of output representation is impossible. For example, during the transition from 0999 to 1000, even a momentary output corresponding to 0990 or 0000 cannot occur.

In response to a switch signal an output reading can be held for any desired period even though shaft rotation continues. Upon removal of the signal the output indication immediately follows shaft position.

Variations of the instrument can be provided for higher output power or three-decade representation.

The shaft position coder and its power supply unit



The Transistor as a Temperature-sensing Device in Temperature Control Systems

By J. E. Pallett*, B.Sc., D.L.C.

The method of using a transistor, in the common-base circuit, for the detection of temperature changes in a temperature controlled system is examined in some detail. It is shown that it has two main advantages over other methods; the sensitivity may be as high as 1V/°C and the output current is directly proportional to temperature. It is, of course limited to temperatures below 90°C for germanium transistors or below 150°C for silicon transistors.

(Voir page 405 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 412)

THE use of a transistor amplifier for the detection of temperature changes in temperature controlled systems has been proposed[1,2], and the method will be examined here in more detail and an improved method will be described. The method, which is useful because of its high sensitivity, makes use of the amplifying property of the transistor. This property is retained over a very wide range of temperature and for a transistor with a constant supply at the input, change of input resistance due to temperature change produces an amplified effect at the output. In a control system with a high open-loop gain the output from the transistor will be maintained substantially independent of temperature and the controlled temperature will be set by varying the electrical input to the transistor. With this in view certain general requirements may be defined. For the system to be stable over a wide temperature range the sensing transistor should have a sensitivity which is substantially independent of the temperature. Also apart from considerations of stability which limit the open-loop gain of the control system, the accuracy of the control will be limited by spurious current changes in the transistor which senses the temperature, produced by random changes in the supply voltage, low frequency fluctuations and effects due to surface leakage. These should be minimized by circuit design and by supplying the input to the transistor from a variable and highly stable source.

In a transistor there are two properties that show an important variation with temperature[3]. These are the collector current when the emitter current is zero, I_{co}, and the voltage between the base and the emitter required to maintain the collector current independent of temperature. Other parameters (the current gain, the base resistance, etc.) also depend on temperature but their effect is of secondary importance. In previous work using the transistor as a temperature sensing element[1,2] the strong temperature dependence of I_{co} has been exploited by using the transistor with the base disconnected or with a high resistance in the base circuit. Under these conditions the collector current is directly related to I_{co} by the equation

$$I_c = \frac{I_{co}}{1 - \alpha_n} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

and it is seen that the variation of I_{co} with temperature is amplified by the current gain of the transistor. Semiconductor theory suggests that I_{co} should be related to temperature by the law

$$I_{co} = K_1 T^3 \exp(-qE_g/kT) \quad \ldots\ldots\ldots (2)$$

where E_g is the energy difference between the conduction and the valence bands in the semiconductor and K_1 is a constant. The exponential part is the more important for germanium and silicon at normal temperatures and I_{co}, and therefore I_c increase in a roughly exponential fashion with rising temperature. The sensitivity dI_c/dT also increases nearly exponentially over a normal temperature range. This may be seen by differentiating equation (2),

$$dI_{co}/dT = (qE_g/kT^2 + 3/T)I_{co} \quad \ldots\ldots\ldots\ldots (3)$$

by using equation (1)

$$dI_c/dT = \frac{(qE_g/kT^2 + 3/T)I_{co}}{(1 - \alpha_n)} \quad \ldots\ldots\ldots\ldots (4)$$

and by substituting for I_{co} from equation (2)

$$dI_c/dt = K_1 \frac{(qE_G/kT^2 + 3/T)}{(1 - \alpha_n)} . T^3 . \exp(-qE_G/kT) \quad \ldots\ldots (5)$$

The increase of sensitivity with increasing temperature leads to difficulty in designing a temperature control which is stable over a wide range of operating temperature. The open-base circuit is also very susceptible to change of surface leakage current and currents due to this latter effect have been shown to be very unstable and subject to slow change even when the transistor is held at constant temperature[4]. These effects may be reduced by careful selection of the transistor and by operating it at a low collector voltage.

It is possible, however, to obtain a sensitivity which is substantially independent of operating temperature and also to avoid the effects of surface leakage currents, by using a common base circuit. In this type of circuit use is made of the variation with temperature of that voltage between the base and the emitter which is needed to maintain the collector current independent of temperature. The sensitivity of the common base circuit with the emitter to base voltage, v_{be}, supplied from a low resistance source may be shown to be nearly independent of temperature by considering the equation for the collector current in an ideal transistor with zero base resistance. The collector current I_c, in terms of the saturation currents of the emitter and the collector junctions, I_{es} and I_{cs} respectively, the voltage between the base and the emitter v_{be}, the voltage between the collector and base v_{cb}, and the forward current gain α_n, is given by

$$I_c = I_{cs}[1 - \exp(-qv_{cb}/kT)] + \alpha_n I_{es}[\exp(qv_{be}/kT) - 1] \quad \ldots\ldots\ldots (6)$$

and rearranging

$$I_c = \alpha_n I_{es} \exp(qv_{be}/kT) + I_{cs} - \alpha_n I_{es} \quad \ldots\ldots (7)$$

It will be assumed here that

$$I_{cs} - \alpha_n I_{es} \ll I_c \quad \ldots\ldots\ldots\ldots\ldots (8)$$

which is usually valid except at the highest temperatures. It is known that I_{es} follows the same temperature law as I_{co} and therefore equation (7) may be abbreviated to

$$I_c = K_2 \alpha_n T^2 \exp[q(v_{be} - E_g)/kT] \quad \ldots\ldots\ldots (9)$$

* *The Postgraduate Medical School, University of London.*

where in the temperature range of interest the term

$$\exp\ [q(v_{be} - E_g)/kT]$$

represents the major component of the temperature variation. If I_c is independent of temperature, v_{be} must vary so that

$$q(v_{be} - E_g)/kT$$

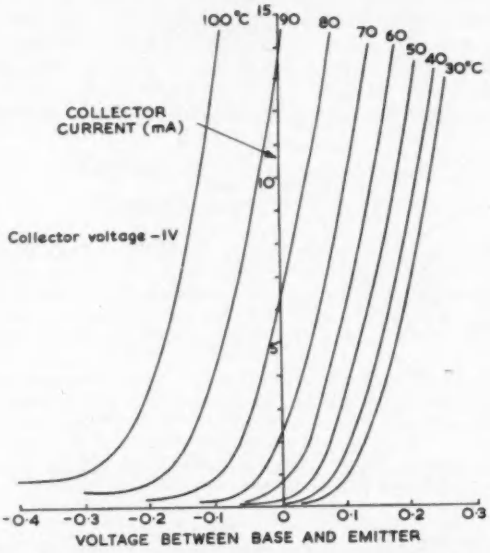


Fig. 1. The variation of collector current with base-emitter voltage at different temperatures for an OC71 type transistor

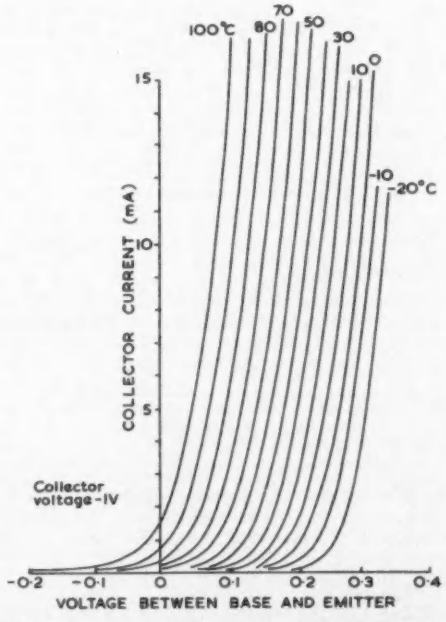


Fig. 2. The variation of collector current with base-emitter voltage at different temperatures for an OC45 type transistor

is also independent of temperature. This condition may be written as $q(E_g - v_{be})/kT = A$, a positive constant independent temperature, or

$$v_{be} = -AkT/q + E_g \quad \ldots\ldots\ldots\ldots\ (10)$$

This last equation shows that the line I_c = constant intersects curves of I_c plotted as a function of v_{be}, for equal intervals of temperature, at points which are equally spaced. Graphs of collector current I_c, have been plotted against base to emitter voltage v_{be} at 10°K increments of temperature for OC71 and OC45 types of germanium transistors and for an OC200 type silicon transistor in Figs. 1, 2 and 3. It will be seen that they are fairly equispaced at moderate temperatures. It may also be shown that the sensitivity of the common-base circuit is relatively independent of temperature by expressing the sensitivity as a function of the voltage gain of the circuit

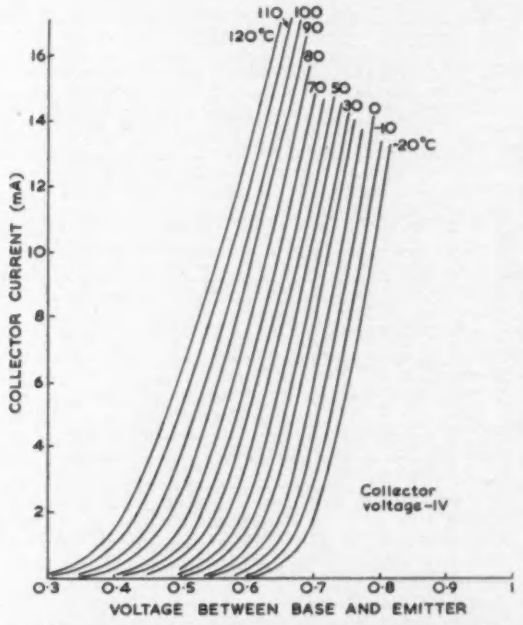


Fig. 3. The variation of collector current with base-emitter voltage at different temperatures for an OC200 type transistor

and the rate at which v_{be} must change to maintain I_c independent of temperature as follows,

$$\left(\frac{\partial I_c}{\partial T}\right)_{v_{be}} = \left(\frac{\partial I_c}{\partial v_{be}}\right)_T \left(\frac{\partial v_{be}}{\partial T}\right)_{I_c}$$

$$= \frac{\text{voltage gain}}{R_L} \left(\frac{\partial v_{be}}{\partial T}\right)_{I_c} \quad \ldots\ldots\ldots\ldots\ (11)$$

The voltage gain from small signal theory is approximately

$$\alpha_n R_L/[r_e + r_b(1 - \alpha_n)] \quad \ldots\ldots\ldots\ldots\ (12)$$

where r_e and r_b have the usual connotation. The sensitivity to temperature change then becomes

$$\left(\frac{\partial I_c}{\partial T}\right)_{v_{be}} = \left(\frac{\partial v_{be}}{\partial T}\right)_T \left(\frac{\alpha_n}{(r_e + r_b(1 - \alpha_n)}\right) \ldots\ldots\ (13)$$

Now on the assumption that only the exponential part of equation (9) is effective in the temperature range of interest,

$$\left(\frac{\partial v_{be}}{\partial T}\right)_{I_c} = \frac{E_g - v_{be}}{T} \quad \ldots\ldots\ldots\ldots\ (14)$$

which is the exponent in equation (8) and it is independent of T if I_c is to be maintained independent of T. It

follows then from equation (13) that the sensitivity will be fairly independent of temperature. Values of $\partial v_{be}/\partial T$ and $(E_g - v_{be})/T$ are compared in Table 1 for three types of transistors and it will be seen that $\partial v_{be}/\partial T$ varies only slowly with temperature.

It is clear from the foregoing discussion that the properties of the common base circuit make it very suitable for use as a temperature sensing element in a high gain control system where the collector current tends to be maintained constant at all operating temperatures. For this application of the circuit the sensitivity will be nearly independent of temperature over a wide range. In setting the operating temperature the base to emitter voltage will be varied until the collector current assumes the correct value at the operating temperature. Since the voltage v_{be} is linearly related to temperature by equation (10) the calibration of the temperature setting is simple and if the voltage is derived from a linear potentiometer the angular rotation of the control dial will be linearly related to temperature. The circuit should be very insensitive to effects due to surface leakage since this current will normally form only a small part of the total collector current with this mode of operation.

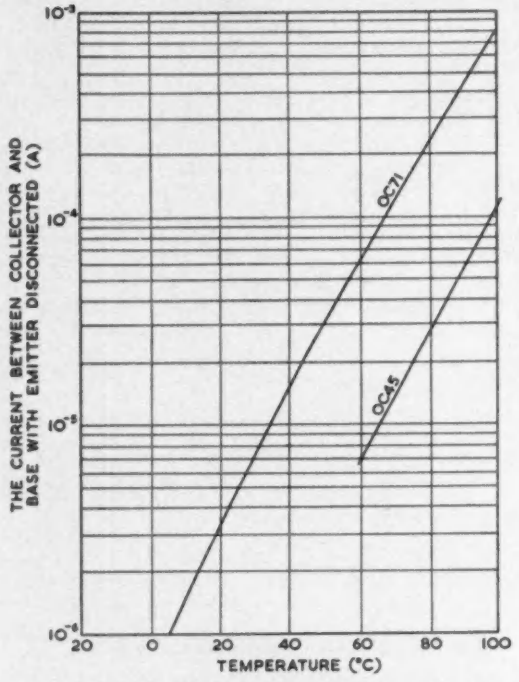


Fig. 4. I_{co} plotted against absolute temperature for an OC71 type and an OC45 type of transistor

The thermal resistance between the transistor and the outer case is important in determining the thermal lag and also how much hotter the junction is than the outer case. For a typical small junction transistor such as an OC71 type the thermal lag is of the order of 15sec (Fig. 5) and the junctions run at about 0·5°C above the surrounding temperature for each milliwatt dissipated in the transistor. These figures could certainly be reduced by more efficient coupling between the transistor structure and the outer case. It is worth noting that in this application of the transistor where the common-base circuit is used there is little advantage in the transistor having a high value of base to collector current gain but there is an advantage in having I_{co} small. It may be seen from Fig. 2 that the characteristics of the OC45 radio-frequency transistor are superior for this purpose to those of the OC71 audio-frequency type, if constant sensitivity is considered the most important factor and in Fig. 4 it is shown that I_{co} is much smaller for the OC45 type. The circuit diagram of an experimental control system is illustrated in Fig. 6 and shows one practical arrangement. The heater, in series with the anode of a pentode valve, consists of several carbon resistors connected in parallel and immersed in an oil bath which is stirred. The performance of the circuit depends to some extent on the amount of lagging but it is found possible to maintain the temperature to within ±0·01°C.

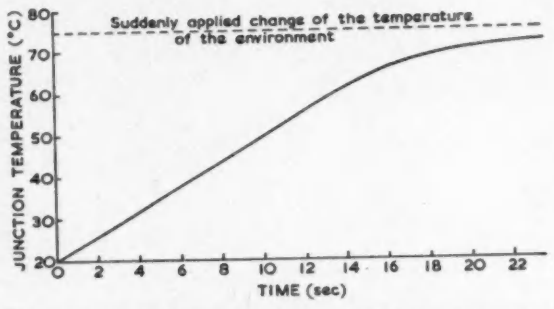


Fig. 5. The junction temperature of an OC71 type of transistor plotted against time following a sudden rise in the surrounding temperature of 55°C

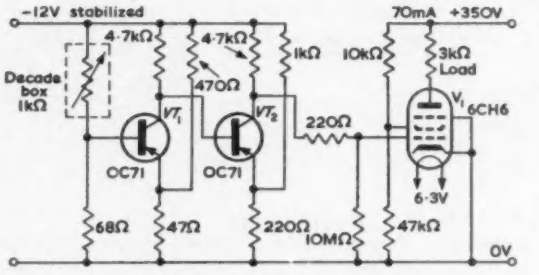


Fig. 6. Experimental temperature controller

The common-base circuit transistor amplifier should provide a useful method of obtaining an electrical output

TABLE 1

	*$(E_g - v_{be})/T$			$(\partial v_{be}/\partial T)_{I_e}$		
T°K	OC45	OC71	OC200	OC45	OC71	OC200
253	0·0017	—	0·0019	0·0022	—	0·0015
263	0·0017	—	0·0019	0·0020	—	0·0015
273	0·0017	—	0·0018	0·0020	—	0·0020
283	0·0018	—	0·0018	0·0020	—	0·0020
293	0·0018	—	0·0019	0·0023	—	0·0015
303	0·0018	0·0019	0·0018	0·0022	0·0020	0·0015
313	0·0018	0·0019	0·0018	0·0020	0·0030	0·0020
323	0·0018	0·0019	0·0018	0·0020	0·0040	0·0015
333	0·0018	0·0020	0·0018	0·0025	0·0040	0·0022
343	0·0018	0·0021	0·0018	0·0025	0·0060	0·0018
353	0·0018	0·0022	0·0018	0·0025	0·0080	0·0025
363	0·0019	0·0023	0·0018	0·0025	0·0090	0·0020
373	0·0019	—	0·0019	—	—	0·0020
383	—	—	0·0019	—	—	0·0020
393	—	—	0·0019	—	—	0·0020

* E_g=0·75eV for germanium and 1·21eV for silicon according to the Handbook of the American Institute of Physics (1957).

proportional to temperature in temperature control systems. Its main advantage over other methods is the high sensitivity which may be as high as 1V/°C for a load of 10kΩ and in cases such as the control of the temperature of thermocouple cold junctions or transistor amplifiers where the temperature is unlikely to rise above the permissible 90°C it may have some advantages over other methods. The temperature range may be extended to 150°C by using silicon transistors.

REFERENCES

1. Sutcliffe, H. Transistor Temperature Controller. *Electronics 30*, No. 13, 81 (1958).
2. Kemhadjian, H. A Simple Temperature Control System for Transistors. *Mullard Tech. Commun. 4*, 186 (1958).
3. Lin, H. C., Barco, A. A. Temperature Effects in Circuits using Junction Transistors. *Transistors I*, 369 (1956). (R.C.A. Laboratories, Princeton).
4. Georg, R. E. Current Creep in Transistors (Letter). *Electronic Engng. 31*, 172 (1959).
   Nicholls, M. R. Current Creep in Transistors (Letter). *Electronic Engng. 31*, 497 (1959).
   Pallett, J. E., Meltzer, B. Current Growth and Noise Spectra in P.N. Junctions in Moist Atmospheres. Proc. International Conference on Solid State Physics in Electronics and Telecommunications. Brussels (1958).

A New Instrument Factory

A new factory has recently been built at Stevenage, Hertfordshire, for the Instrument Wing of English Electric Aviation's Guided Weapons division. It has been specially designed and built for advanced research into, and production of, new and specialized instruments and in particular, precision gyroscopes.

At present about 40 per cent of the output from the Instrument Wing is for two of British Aircraft Corporation's major guided weapons—Blue Water and Thunderbird, which are also both produced at Stevenage. But now the techniques used in the production of the infinitely accurate gyroscopes and other guidance equipment for these are being adopted in the development of equipment for the mines, surveying, the steel and electrical industries, long-range pinpoint navigation by sea, air and in space, and the expanding field of electronic computers.

The Instrument Wing was first set-up by English Electric Aviation as part of the plan to build comprehensive facilities for the manufacture of complete guided weapons systems. At first, the Wing developed and produced relatively simple and large displacement and rate gyroscopes for Thunderbird, the British Army's ground-to-air missile. Later, when development of the Blue Water missile for the Army was ordered, it was necessary to take out a licence with the Minneapolis-Honeywell company of the U.S.A. for the manufacture and development of their seven-ounce miniature integrating gyroscope (the MIG). It has now been in production at Stevenage for two years and is the only miniature inertial quality gyroscope being made in Europe.

The starting of work on the MIGs coincided with the decision to expand the Instrument Wing into a factory with the most advanced and comprehensive facilities for this type of work in Europe. To do this the factory had to be built, equipped with highly specialized equipment and staffed with expert technicians. The work now going on there is being done to new and very high standards, and production test equipment consists of measuring machines which are normally used only in standards rooms.

Dust is excluded from the assembly rooms by filtering the air as it enters the building. Dust particles larger than 0·1μ are removed. The temperature of these rooms is maintained at 72°F and humidity at between 35 and 45 per cent.

Because the instruments are extremely sensitive, special precautions have to be taken to ensure that they are isolated from all vibrations when under test. The whole Instrument Wing is a single-storey building which helps to reduce vibration caused by high winds. All moving machinery, including the air conditioning and cleaning plant for the Wing, is 80ft away from the building and all connexions for air filtration, temperature and humidity control are by flexible overhead ducts. All sources of vibration—express trains on the railway a quarter of a mile away, footsteps in the corridors or nearby road traffic—are excluded by testing the instruments on concrete plinths attached to 50-ton concrete blocks supported on inflated rubber bellows. Below the rubber bellows are further large blocks of concrete embedded deep in the foundations.

A special centrifuge for measuring the performance of accelerometers under known conditions of acceleration can work to an accuracy of a few parts in a million. To achieve this it rotates on an air cushion above a slab of solid granite, the central bearing being air lubricated. An instrument system monitors the speed of rotation and the change in radius of the centrifuge arm, and this information is accurately printed out once every three revolutions. This unique test device is made available for use by research establishments and other firms.

Only staff actually working in the Instrument Wing are normally allowed inside. They have to go through changing rooms to don special smocks and caps. In the super-clean areas where final assembly is done, the staff make a further change into overall suits and anti-static boots. Over and above all these precautions, the actual instrument assembly is done under special cabinets where super-clean air is continually pumped over the assemblers' hands to prevent invisible dust particles from settling on the work.

To match these facilities, the Instrument Wing has a staff of engineers who are qualified in all the various sciences related to instrument design, and the design of complete systems exploiting the performance of the basic instruments. These new systems are finding applications in many new problems of industry. They include control equipment for steel rolling mills and precision tape heads for digital computers.

An example of the kind of system made possible by using these new techniques is the PIM system—Precision Indication of the Meridian. This exploits the extreme sensitivity of the floated rate integrating gyroscope to detect North within one minute of arc by sensing the horizontal component of the earth's rotation. The gyroscope used in PIM is so sensitive that it can detect a turning rate equivalent to one rotation of the earth in 20 years. PIM has been developed for the War Office for the purpose of alignment of field artillery and tactical guided weapons in the dark or bad weather, or where there are no known survey points. Interest has also been shown in the PIM system for survey in mines and tunnels where normal visual and astronomical methods are not practicable.

In addition to the development of advanced production techniques essential in the manufacture of high performance instruments, it has also been necessary to design and develop a wide range of specialized production test equipment. One item is the IFG 106 gyroscope test equipment. This is capable of carrying out a full range of tests on a rate integrating gyroscope. It is now in production by the Instrument Wing and has been sold to users of MIG gyroscopes, and is being marketed for the users of rate integrating gyroscopes.

The Direct Reading Permeameter is probably the only device of its kind in the world for obtaining instantaneous readings of permeability of materials on components. Such checks are necessary in the case of high permeability materials used for the lamination of precision spin motors, pick-offs etc. The permeameter provides a rapid, convenient and accurate means of checking laminations or sub-assemblies of high permeability materials and so ensures that unsuitable materials are not built into the finished product. There are possibly many other applications of the permeameter in other fields of industry and it is being produced in small quantities for the commercial market.

Control Pulse Generation for a Digital Differential Analyser

By P. L. Owen*, B.A., M. F. Partridge*, M.A., and T. R. H. Sizer*, A.M.I.E.E.

This article, the first of a series of four describing the design and circuit details of a transistorized digital differential analyser, deals with the control pulse generation. While in essence the theory of the generation is merely one of pulse division, the processes by which this is accomplished are unusual particularly in the case of those associated with the parallel logic in the machine.

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

IN a serially operated digital computer it is necessary to identify each word period, the digit period within a word and to provide synchronized control signals for performing various logical operations. The method of meeting such requirements is by means of basic waveforms.

To define, say, fifty words requires a waveform generator with fifty output lines, a pulse appearing at a particular output during the period in time when the associated word occurs. Digit periods are similarly identified by a faster generator whose several output lines deliver a pulse during successive sub-divisions of every word.

There are four such generators in CORSAIR[1], the relationship between the pulses is shown in Fig. 1(a) and (b). In all, six discrete groups *A*, *D*, *E*, *F*, *P* and *p* are needed. The word pulses, designated A_1, A_2 ..... A_{50} are formed by combining pairs of outputs from the *E* and *F* pulse generators. Ten *E* and five *F* pulses are of mark-to-space ratio 1:9 and 10:40 in units of one *A* pulse. The *D* pulses are alternate *P* pulses amplified to the levels necessary in the address system. Twenty individual digit periods comprise each word period and are identified by *P* pulses designated P_1, P_2 .... P_{20}.

Each *P* pulse is further divided into four *p* pulses designated p_1, p_2, p_3 and p_4 because the majority of the logical operations in the computer occurring within the duration of one *P* pulse fall into a four part rhythm:—

(1) Clear destination

(2) Transfer

(3) Clear source

(4) Refill.

The 1Mc/s Oscillator

The fundamental time-piece is a high-stability quartz crystal maintained in oscillation by a grounded collector transistor circuit. In a standard form the unit is manufactured by Messrs. Cintel Ltd as a 1Mc/s oscillator type 7034A. The circuit has been modified to include a pulse shaper for its present application and re-engineered to fit a smaller board. A circuit is shown in Fig. 2.

The Pulse Shaper

The circuit of the shaper is shown in Fig. 3; R_6 and C_6 decouple the d.c. component of the a.c. signal. VT_3 is switched in an inversionary mode, R_{10}, R_7, R_8 and C_7 form a negative feedback loop which preserves an output of unity mark-to-space ratio over a range of operating conditions and transistor parameters. VT_4 is a buffer invertor with its collector load determined by the requirements of the direct coupled technique[2] used in subsequent circuits.

The output from this invertor is a square-wave of frequency 1Mc/s, negative-going from earth with an amplitude of −0·5V.

The Pulse Generators

The first two pulse generators to be described derive the *p* and *P* pulses. Surface barrier transistors type SB-240 are used throughout, employing the direct coupled technique. It is not proposed to discuss this technique as it has been dealt with in detail elsewhere[2].

TABLE 1

INTEGER	NATURAL BINARY
0	0 0
1	1 0
2	0 1
3	1 1

TABLE 2

INTEGER	CYCLIC BINARY REPRESENTATION
0	0 0
1	1 0
2	1 1
3	0 1

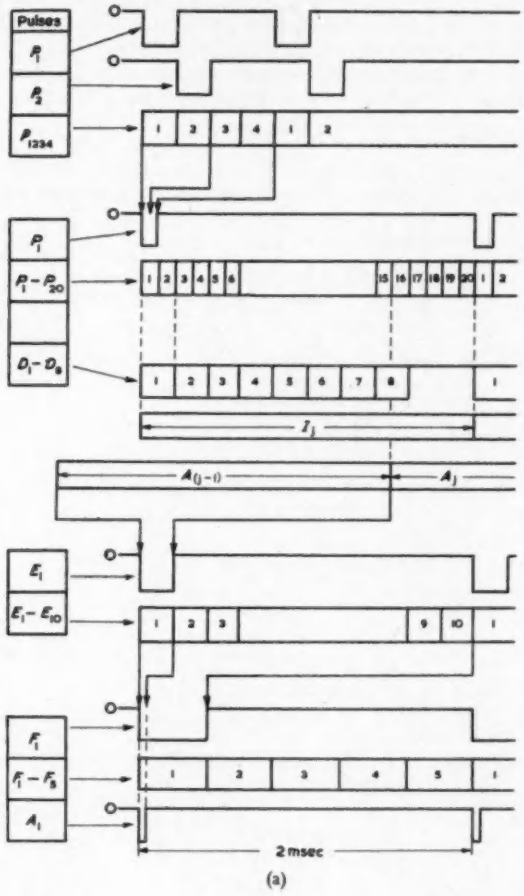
The p Pulse Generator

A block diagram of the *p* pulse generator is shown in Fig. 4. The main circuit elements are a cyclic binary unit and a pulse divider which together provide a unique four digit count with the counting pattern at one half clock frequency. Tables 1 and 2 illustrate the difference in number representation between natural and cyclic binary counting. Use of the latter avoids the simultaneous change of state of two information channels and hence the possibility of a spurious output pulse. Typical waveforms illustrating this point are shown in Fig. 5(c) and Fig. 5(d).

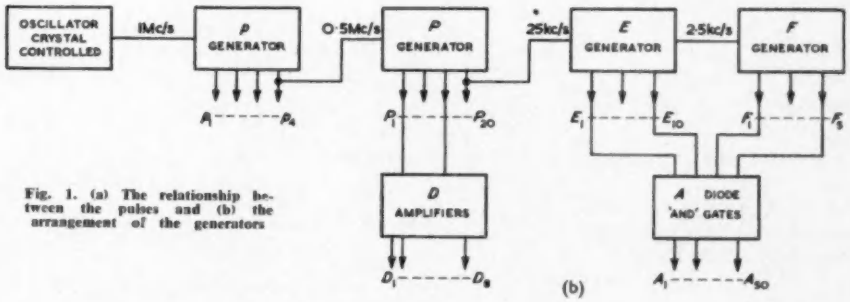
The circuit of the cyclic binary unit is shown in Fig. 5(a). It consists of two flip-flops *M* and *N*, the present state of one being controlled by the previous state of the other. The transverse control is effected by means of, in the case of *M*, VT_5 and VT_2 in series and VT_8 and VT_2 in series. Flip-flop *N* is controlled by VT_9-VT_4 and VT_{12}-V_4. The role of VT_3 is important because it is this element which inverts the trigger pulse so defining the phase displacement between *M* and *N*; this will be made clear in the following paragraphs.

Referring to Fig. 5(a) the trigger input, already shaped to be a series of negative-going pulses from earth with a constant, equal mark-to-space ratio, is applied to the base of VT_1 which acts as an isolating invertor. From the collector of VT_1 a signal *T* is obtained which is used to drive VT_2 and the invertor VT_3, which in turn drives VT_4.

* *Royal Aircraft Establishment, Farnborough.*



(a)



(b)

Fig. 1. (a) The relationship between the pulses and (b) the arrangement of the generators

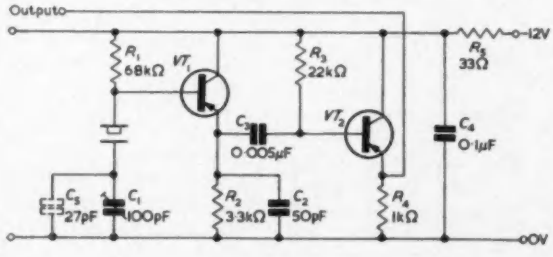


Fig. 2. The crystal oscillator circuit

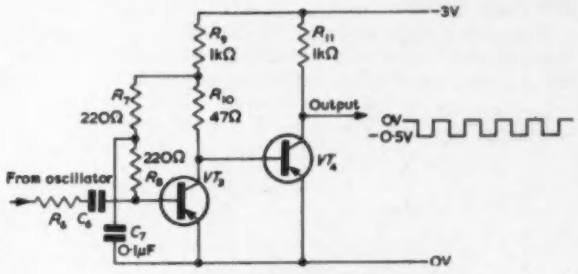


Fig. 3. The pulse shaper

Transistors used in direct coupled circuits of this form switch into the conducting mode when the base-emitter signal changes from zero to a negative potential, made to correspond in this application, to a logical change from 0 to 1. It can be seen, therefore, that VT_2 is switched into a conducting mode when the trigger pulse T changes from 0 to 1 but, due to the inverting action of VT_3, VT_4 is switched into a conducting state when the trigger pulse changes from 1 to 0. It is only necessary now to start the chain of events and it will be shown that the four outputs of the flip-flops will conform to the sequence in the following truth table:

M	M'	N	N'	p PULSE
1	0	0	1	p_1
0	1	0	1	p_2
0	1	1	0	p_3
1	0	1	0	p_4

At the instant of switch-on the states of M and N are arbitrary. Assume N' is negative (equal to 1), VT_{10} will be conducting and VT_{11} non-conducting. As N' is connected to the base of VT_5, this transistor will conduct as soon as its emitter is earthed and this takes place when the trigger pulse T, at the base of VT_2 changes from 0 to 1; M will then be earthed. Assuming VT_7 had been conducting, then VT_7 will be switched off and M' changed to 1. The state of affairs now corresponds to line two of the truth table.

When the trigger pulse T changes from 1 to 0, VT_2 is cut off, but as the inverse, T', is applied to VT_4, the base of VT_4 changes from 0 to 1 and VT_4 conducts. As M' (a 1) is connected to the base of VT_{12}, N is earthed and flip-flop N changes state. Flip-flop M does not change because VT_2 is not-conducting, thus the state of affairs corresponds to line three of the truth table.

A similar process is repeated to conform to line four and again to line one. Thereafter the cycle repeats and is continuous until the train of trigger pulses is interrupted.

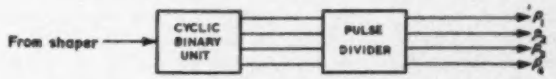


Fig. 4. The p-pulse generator

The Pulse Divider

The pulse divider shown in Fig. 5(b) is, in effect, a multi-input selection gate. The connexions required to produce the p pulses are obtained from the truth table.

$$p_1 = M.\ N'.$$
$$p_2 = M'.\ N'.$$
$$p_3 = M'.\ N.$$
$$p_4 = M.\ N.$$

prevented from reaching 2^5 by a resetting device which is operated by the twentieth pulse, which for convenience is called P_{20} stopping and resetting the sequence.

A decoder is necessary because the outputs of the binary counter are not in a form required by the computer.

Circuit Description

A block diagram of the P pulse generator is shown in Fig. 6(a). p_1 is the counting trigger pulse; p_2 and p_3 assist

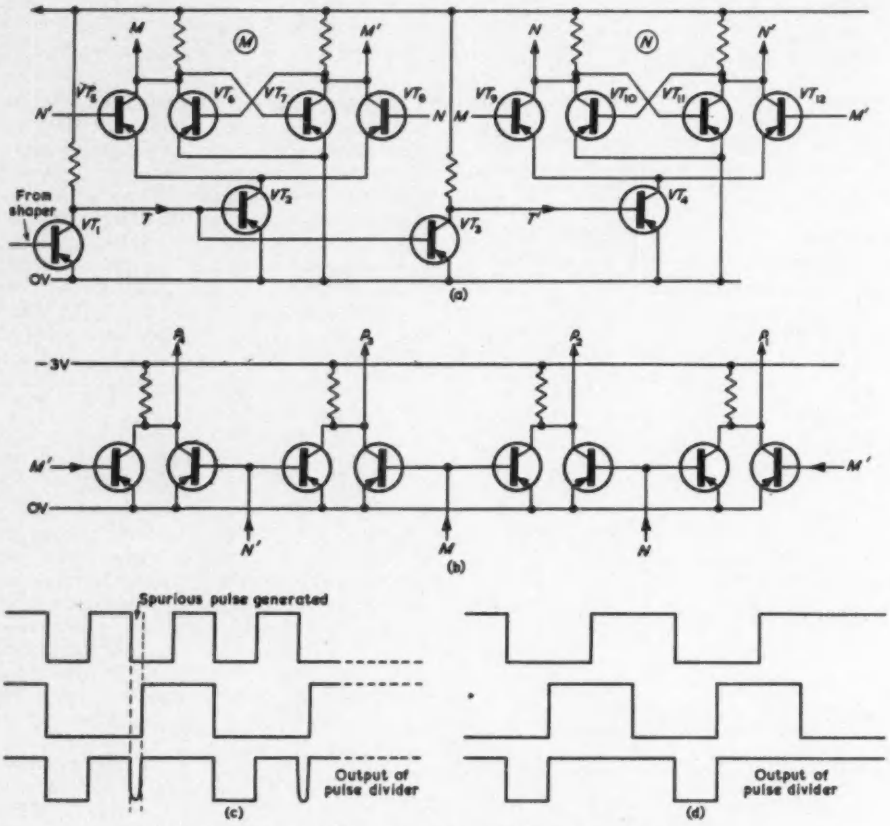


Fig. 5. The cyclic binary unit, the pulse divider and typical waveforms

Treating the symbols M and N as Boolean variables, the four equations above are modified so that an OR gate configuration can be used in the selection gate thus:

$$p_1 = (M' + N.)'$$
$$p_2 = (M + N.)'$$
$$p_3 = (M + N'.)'$$
$$p_4 = (M' + N'.)'$$

The P Pulse Generator

Basically the P pulse generator consists of a five digit binary counter the outputs of which are decoded by a diode matrix with twenty output lines. The arrangement of the diodes is such that for each combination of the binary counter one output line is energized.

When p pulses are fed into the first binary counter the series starts a binary count which repeats after $2^5 (= 32)$ steps. A sample of the output stage, at any time, will be a binary representation of the number of pulses up to that time. In practice the counter is

TABLE 3
Values of the variables for all the P-pulses

P-PULSE	VARIABLE A	B	C	D	E
1	1	1	1	1	1
2	0	0	0	0	0
3	1	0	0	0	0
4	0	1	0	0	0
5	1	1	0	0	0
6	0	0	1	0	0
7	1	0	1	0	0
8	0	1	1	0	0
9	1	1	1	0	0
10	0	0	0	1	0
11	1	0	0	1	0
12	0	1	0	1	0
13	1	1	0	1	0
14	0	0	1	1	0
15	1	0	1	1	0
16	0	1	1	1	0
17	1	1	1	1	0
18	0	0	0	0	1
19	1	0	0	0	1
20	0	1	0	0	1

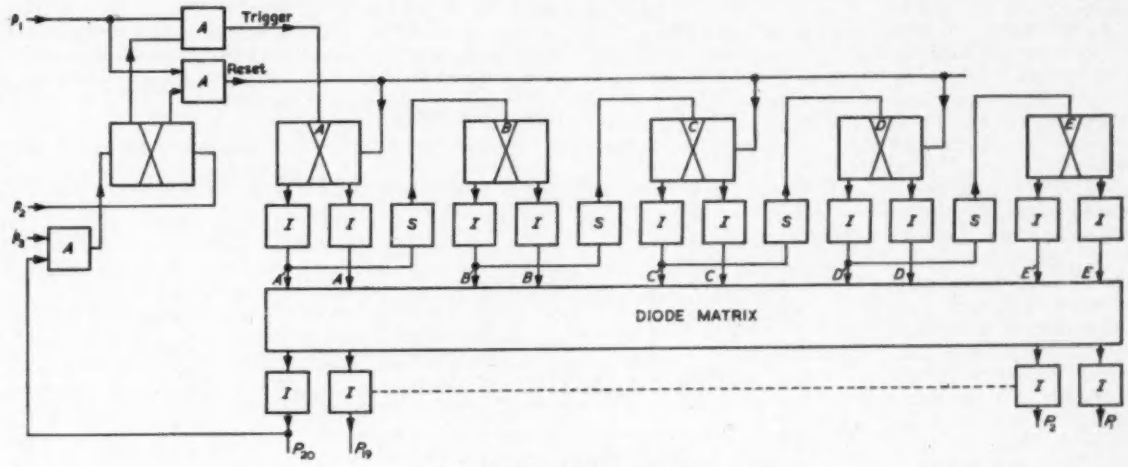


Fig. 6. (a) The P-pulse generator

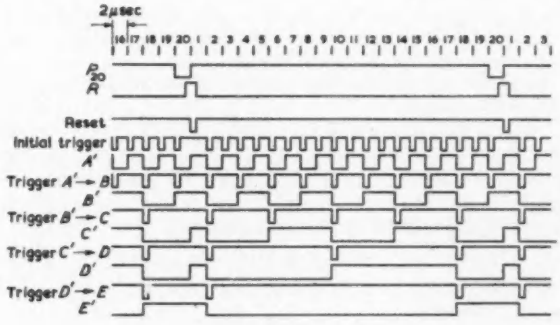


Fig. 6. (b) The P-pulse generator waveforms

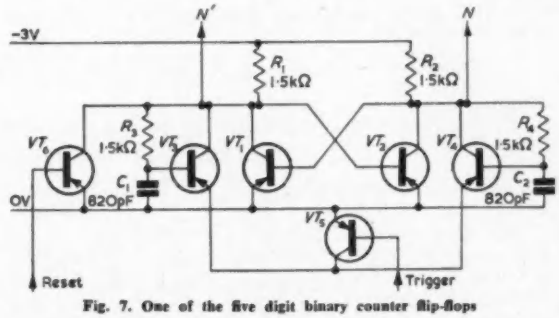


Fig. 7. One of the five digit binary counter flip-flops

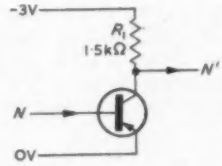


Fig. 8. (left) A buffer invertor

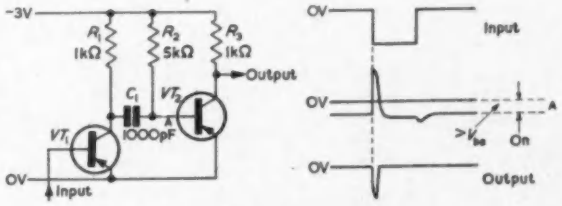


Fig. 9. A shaping circuit

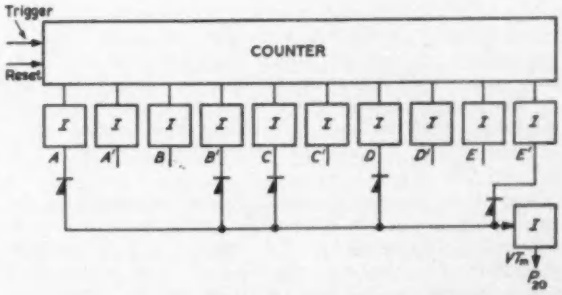


Fig. 10. The diode combination for selection of the reset signal

in forming a delay and resetting operation. Complete waveforms are shown in Fig. 6(b).

The five digit binary counter consists of five complementing flip-flops in cascade; a circuit of one such flip-flop is given in Fig. 7. The flip-flops labelled *A*, *B*, *C*, *D* and *E* in Fig. 6(a) are of this type. *A* is triggered by p_1 through gate *A*, then *A* triggers *B*, *B* triggers *C*, etc. The trigger pulses to successive flip-flops pass first through invertors, Fig. 8, acting as buffers then through shaping circuits, Fig. 9. The latter are used to shorten the trigger pulses so that they are standardized at 0·5μsec for each flip-flop and do not coincide with the resetting signal.

The decoder is a diode matrix; a complete circuit is not given but Fig. 10 shows the diode combination for the selection of the reset signal, which is P_{20}. Nineteen other combinations select P_1 *to* P_{19}. The state of flip-flop *A* monitored, say, on the left-hand side is represented by the symbol *A* where $A = 1$ when the side is at a negative potential and $A = 0$ when the same side is at earth potential. Because both outputs of a flip-flop are used, the symbol *A* specifically defines the left-hand output and *A'* the right-hand. Thus there is the relationship when $A = 1$, $A' = 0$. Symbols *B*, *C*, *D* and *E* are similarly associated with the other four flip-flops.

The state of the counter may now be defined uniquely by a combination of values given to these variables. For example, the combination 00000 means that all the left-hand outputs are at earth potential. Values of the variables for the twenty P-pulses are given in Table 3 which shows that for P_{20}, the variables A, B, C, D and E have the values 0.1.0.0.1 respectively. The state of the counters corresponding to these values of the variables is then such that the collectors at zero are A, B', C, D, E' respectively. Considering P_{20} only, these collectors are each connected through a diode to the base of a single transistor; no base current flows in this transistor because all the collectors are at zero, thus the collector of the single transistor is at a negative potential. For any other combination of the same five collectors at least one will be negative and allow a sufficient flow of base current in the single transistor to bring its collector up to zero. Thus a negative output pulse appears only for the combination of values 0, 1, 0, 0, 1 which is P_{20}. The other P-pulses are generated by suitable combinations.

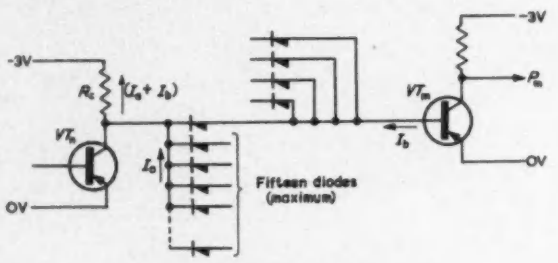


Fig. 11. A typical line in the matrix

Fig. 11 shows the detailed circuit of a typical line in the matrix where VT_n and VT_{in} are input and output invertors respectively. It can be shown that using SB-240 transistors and CV425 diodes the optimum value of R_c is 470Ω.

The resetting device is equivalent to a bistable circuit with a two-input AND gate on each side. The circuit diagram is given in Fig. 12 and the principle of operation is as follows.

Assume P_{20} has not arrived as a negative pulse, then the base of VT_2 is at earth potential and this transistor is non-conducting. On the arrival of the first p_2 at VT_5 the right-hand side is earthed and the flip-flop is set in the state where the left-hand side is negative and the right-hand side zero. VT_{10} is thus in a conducting state and the signal p_1' appearing at the base of VT_{11} is inverted to allow a train of p_1 pulses to appear on the trigger line.

Eventually, P_{20} is produced as a negative pulse which operates the gate VT_1 — VT_2 allowing the signal $(P_{20} \cdot p_3)'$ to change the state of the flip-flop. A 'one' appears at the base of VT_7 operating the gate VT_6-VT_7 and p_1 appears as the reset signal. The base of VT_7 is negative until the flip-flop is changed by the next p_2 so that only one pulse appears from VT_8 before the gate is inhibited.

Reference to Fig. 6(a) and (b) shows that the reset signal is applied to the relevant counters simultaneously changing A', C' and D' to zero, B' and E' being already in the zero state. No spurious trigger pulses are generated by this process because none of the primed outputs from which they are derived is changed from 0 to the 1 state.

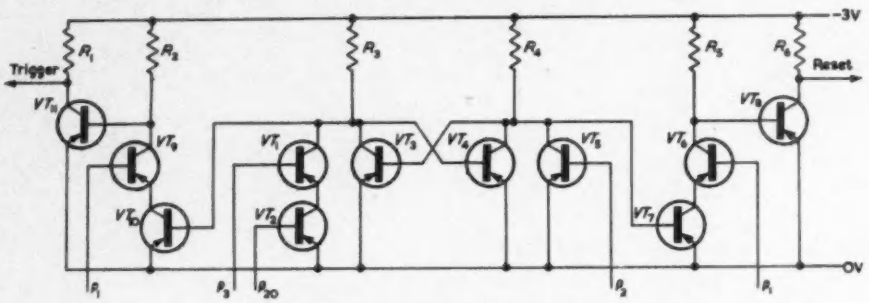


Fig. 12. The resetting circuit

The Word Pulses

The p and P pulses just described are associated with digit periods of words in serial representation and control the basic arithmetic pattern. The next set of pulses to be described are the A, E and F pulses which are needed to define the individual words and the D pulses which define the increments.

There are several discrete parts of the computer requiring these pulses and the problem of the logical design of the generators is reduced to finding a common form suitable for all these applications. The pulses have to serve the following components of CORSAIR

(1) The main store, a ferrite core matrix.

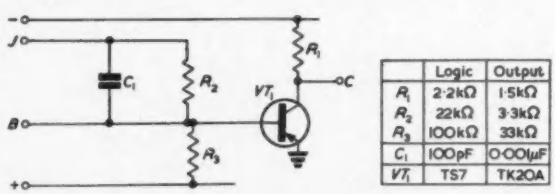
(2) The increment store, a set of active tristable devices.

(3) The address system, essentially a pulse distributor.

(4) The input/output system whereby the individual integrator registers are filled and their contents indicated.

(5) Peripheral equipment, e.g. a digital-analogue convertor.

The chosen system divides the integrators into five groups of 10, each group associated with an F pulse, and differentiates them within the groups by the ten E pulses. This requires the division of the P pulse frequency by 10 to generate E pulses, and of the E frequency by five for the F pulses. The division is accomplished by combination of one divide by two stage and two divide by five stages.



	Logic	Output
R_1	2·2kΩ	1·5kΩ
R_2	22kΩ	3·3kΩ
R_3	100kΩ	33kΩ
C_1	100pF	0·001μF
VT_1	TS7	TK20A

Fig. 13. An invertor element

The E, F and D Pulse Generators

The circuit elements used in the E, F and D generators may conveniently be separated into an invertor element,

a diode matrix, a counter input gate, an emitter-follower element, binary counter and a *D*-pulse switch.

The invertor element is shown in Fig. 13. There are two designs, similar apart from component values. The first is the logical invertor; the second type is used as an output stage. Each has two inputs designated *J* (high impedance) and *B* (low impedance) and an output point *C*.

A negative signal applied to *B* or *J* will cause a base current I_b to flow. If $I_b > (V/\beta' R_1)$, where β' is the large signal current gain of the transistor, the transistor will bottom. The potential at *C* will then correspond to a 0 signal. If the input signal is such that *B* is held positive, the transistor will cease to conduct and the output will be *V*, the negative rail seen through R_1.

Points *J* and *C* are compatible and may be connected directly together. The *B* input accepts both short positive pulses, which are used in switching the transistor off, and low level signals from the direct coupled circuits. Potentials extant at *J* and *C* are those corresponding to the logical signals 1 (negative) or 0 (zero); *J* and *C* will be treated hereafter as logical variables describing such signals.

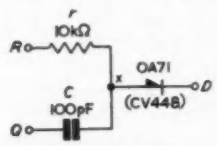


Fig. 14. An input gate

The diode matrix consists of sets of two or three-input diode 'OR' gates mounted for convenience five gates to a board. Two different layouts are used designated matrix 1 and matrix 2. Matrix 1 is used in the counter input gate; matrix 2 is a six input, five output device, one input being neglected when used in the *F* pulse generator.

Matrix 1 in addition to five two-input OR gates, carries five INPUT gates of the type shown in Fig. 14. These are conventional resistor-capacitor diode circuits transmitting a positive pulse on receipt of a positive going edge ($1 \rightarrow 0$ signal) at the capacitor input only if the resistor input has been held at 0 for a period $t \sim CR$ previously. The gates are designed to feed the *B* input of an invertor.

The emitter-followers are conventional circuits used as buffer stages, having input and output labelled *B* and *E* respectively where logically $E = B$.

The divide-by-two counter stage consists of two logic invertors and two INPUT gates.

The *D* pulse switches operate as follows. A *P* pulse (direct-coupled level) at the input of VT_1, Fig. 15, switches the full rail voltage across the transformer primary. The corresponding voltage on the floating secondary closes the transistor switch VT_2. R_1 and C_1 are included in the emitter of VT_1 to limit the primary current under fault conditions. The output signal is logically identical to the input *P* pulse, but amplified to −12V ('1' signal) and lengthened by delays in the circuit. Such large signals are necessary in the operation of the address system.

The operation of the *E* and *F* pulse generators will now be described in terms of the foregoing circuit elements.

A description of the binary counter has been included to help in the understanding of the divide by five stage described later. The counter consists of two invertors labelled 6 and 7 (to avoid confusion with the ÷ 5 stage) and connected so that:—

$$J_6 = C_7$$
$$J_7 = C_6$$

Now $C_n = J_n'$ $(n = 6,7)$

therefore $C_6 = C_7'$

and there are two solutions representing static states α and β of the system as recorded in Table 4. The input gates 6 and 7 are connected thus:—

$$D_6 = B_6$$
$$D_7 = B_7$$
$$R_6 = C_5$$
$$R_7 = C_7$$
$$Q_6 = Q_7 = Q \text{ (binary input)}$$

If the state α has been set up for a time approximately *RC*, a positive edge applied to *Q* will appear at the output

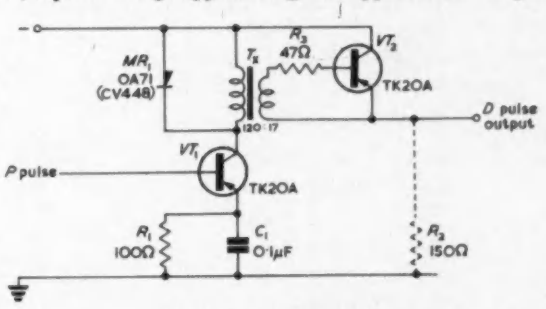


Fig. 15. The D-pulse switch

D_7 only (since $R_7 = C_7 = 0$ and $R_6 = C_6 = 1$) causing a change to the stable state β. A later positive edge at *Q* will switch the bistable back to state α. In the pulse generator *Q* is driven by the signal P_{16}' from an invertor amplifier and the signals at C_6 and C_7 will be *E* odd and *E* even, each changing at the beginning of P_{16}.

There are many ways in which a divide by five element could be constructed, such as a forced three stage binary counter, five stage shift register, etc. The method chosen is to use a five stage ring counter, designed to be self programming. This means that the logical construction is such that it can assume only five discrete states and must progress through them all in sequence. As the final signal required is in the form of a short mark ('1') followed by a long space ('0') a counting pattern giving outputs 00100001000010 . . . might be thought desirable. In fact it is necessary to introduce buffers between the counter and the output channels and as these are most suitably invertors then a counting pattern which is the inverse of the above is more appropriate. It so happens that a counting pattern 10100101001 . . . is very easy to generate, and the desired pattern 01111011110 . . is equally easily derived from it using OR gates. The logical derivation of the 1010010100 pattern is given here in terms of Boolean algebra, as in the discussion of the binary counter.

The counter consists of five logic invertors interconnected in a ring by diode OR gates. Numbering the invertors 1, 2..5 cyclically the equations represented are:—

$$J_n = C_{n-1} + C_{n+1}$$

As usual $J_n' = C_n$ since none of the *C* points is connected directly to another.

TABLE 4

STATE	C_6	C_7
α	1	0
β	0	1

Eliminating J from these equations leaves

$$C_n' = C_{n-1} + C_{n+1} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Adding (OR) C_n to each side.

$$C_n + C_n' = 1 = C_{n-1} + C_n + C_{n+1} \text{ for all } n \text{ modulo } 5.$$

Therefore there must be a 1 in each group of three adjacent outputs. Multiplying (AND) each side of equation (1) by C_n gives

$$C_n C_n' = 0 = C_n . C_{n-1} + C_n . C_{n+1}$$

Therefore $C_n . C_{n-1} = 0$ for all n (modulo 5).

Thus no two adjacent outputs may be 1. The only allowed combinations under these conditions are consecutive groups of five from the sequence 1010010100. These are enumerated in Table 5. The system is thus pentastable.

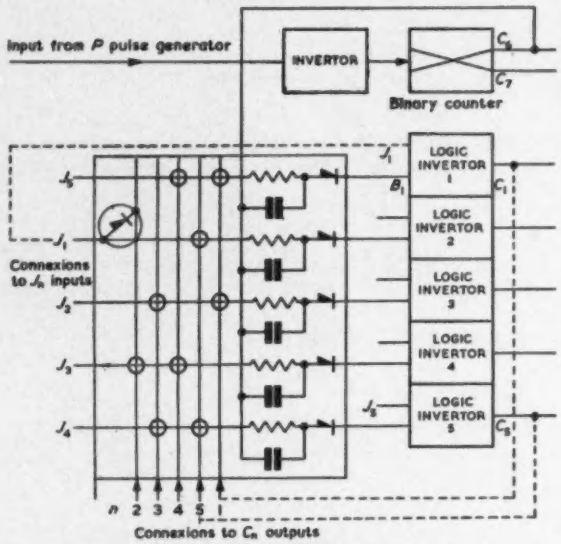


Fig. 16. Connexion of the five input gates

As a divide by five counter it is made to progress through the states $\gamma\,\delta\,\epsilon\,\xi\,\zeta\,\gamma$ .. in sequence (Table 5), changing at each input pulse. To achieve this the five input gates are connected as shown in Fig. 16.

$D_n = B_n$

$R_n = J_{n-1}$

$Q_n = Q$ = output of previous stage (i.e. the binary counter in the case of the E ring, or the E pulse generator for F).

Thus in the state γ, R_2, $= R_4 = 0$, $R_1 = R_3 = R_5 = 1$. Remembering that the n^{th} input gate transmits a positive pulse as Q_n goes from 1 to 0 only if R_n has been held at zero for a period approximately RC, it is seen that in this state B_2 and B_4 only will be driven positive by an input pulse. Thus C_2 and C_4 will momentarily be driven negative and acting via the diode matrix will set all other collectors to the 0 condition, leaving the system in the state δ. The input gates reset to the new condition and on receipt of the next impulse will switch the pentastable to ϵ, and so on.

TABLE 5

STATE	C_1	C_2	C_3	C_4	C_5	J_1	J_2	J_3	J_4	J_5
γ	1	0	1	0	0	0	1	0	1	1
δ	0	1	0	1	0	1	0	1	0	1
ϵ	0	0	1	0	1	1	1	0	1	0
ξ	1	0	0	1	0	0	1	1	0	1
ζ	0	1	0	0	1	1	0	1	1	0

The pentastable, driven by the bistable, constitutes a system which proceeds successively through ten stable states. The output signals, however, appear on 2 + 5 lines (C_6, C_7, C_1, C_2, C_3, C_4, C_5) and must be decoded to produce the E pulses required. This is fortunately a simple matter requiring only a further diode matrix of OR gates, and ten output invertors. Emitter-follower buffers are inserted between the logic invertors and matrices (Fig. 17).

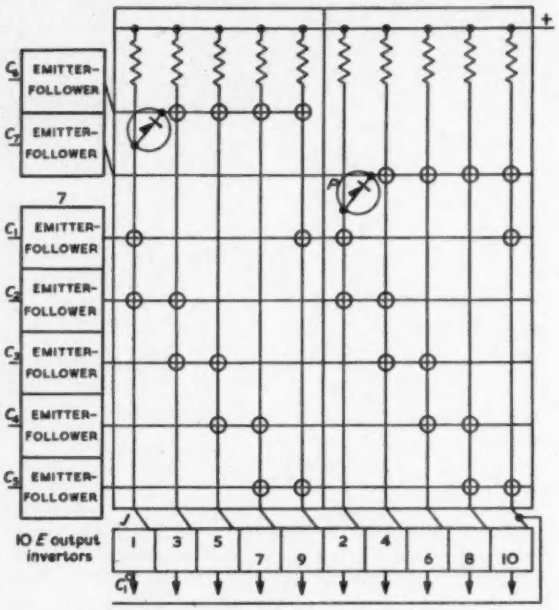


Fig. 17. Arrangement of buffers and logic invertors

Labelling the output invertors, 1, 2, ... $2m - 1$, $2m$ .... and distinguishing the output invertors by superscript °, the following equations are represented by the diode matrices:—

$$J_{2m-1}^{\circ} = C_6 + C_m + C_{m+1}$$

$$J_{2m}^{\circ} = C_7 + C_m + C_{m+1}$$

Again $C_{2m-1}^{\circ} = (J_{2m-1}^{\circ})'$

$$C_{2m}^{\circ} = (J_{2m}^{\circ})'$$

Thus each invertor gives a '1' output signal only when its three input signals are zero. This occurs for but one

TABLE 6

STATE	$\frac{\epsilon}{\beta}$	$\frac{\epsilon}{\alpha}$	$\frac{\xi}{\beta}$	$\frac{\xi}{\alpha}$	$\frac{\zeta}{\beta}$	$\frac{\zeta}{\alpha}$	$\frac{\gamma}{\beta}$	$\frac{\gamma}{\alpha}$	$\frac{\delta}{\beta}$	$\frac{\delta}{\alpha}$
C_6	0	1	0	1	0	1	0	1	0	1
C_7	1	0	1	0	1	0	1	0	1	0
C_1	0	0	1	1	0	0	1	1	0	0
C_2	0	0	0	0	1	1	0	0	1	1
C_3	1	1	0	0	0	0	1	1	0	0
C_4	0	0	1	1	0	0	0	0	1	1
C_5	1	1	0	0	1	1	0	0	0	0
One Output	1	2	3	4	5	6	7	8	9	10

of the ten states, as may be seen from Table 6.

The F pulse generator comprises a similar set up but omitting the bistable, and is driven by the signal E_{10}. This signal goes from $1 \rightarrow 0$ at the end of E_{10}, causing the second pentastable to switch. There are now five outputs, generated in invertor stages as are the E pulses, via similar logic.

$$J_n^\circ = C_n + C_{n+1}$$
$$C_n^\circ = (J_n^\circ)'$$

The fastest part of the circuit, the binary counter, has an input frequency of 25kc/s but both it and the pentastable will operate above 100kc/s without modification. Spurious pulses due to switching transients are eliminated by hole storage effects in the output invertors. This leads to an overall delay of $1\frac{1}{2} \pm \frac{1}{2}\mu$sec at the beginning of the pulses but this is of no consequence as the pulse edges are not used for timing purposes.

The A Pulse Generator

The A pulses which define the individual words are formed by combining the appropriate E and F pulses in a set of diode AND gates. This operation, however, only takes place in the Address Unit. Throughout the remainder of the machine E and F pulses are available in unmodified form.

Constructional Details

Printed wiring techniques are used throughout. Each board is 4½in × 4½in × 1/16in copper clad laminate. There are 22 rhodium flashed contacts per board designed to fit into a twenty-two way socket. Connexions between sockets and to plugs is by means of loomed wiring.

No attempt has been made to achieve a high component density. Because of the experimental nature of the work, each printed board has been laid out to facilitate changing of component values and to allow modifications to the copper routes. The boards have proved singularly robust and capable of withstanding quite severe treatment. No evidence of unreliability has appeared either on the laminate or due to excessive contact resistance in the socket.

The complete chassis slides into a standard 19in cabinet, connexion being made to vertical cable runs by means of thirty-two way plugs and sockets.

Conclusions

The equipment described has operated for over fifteen hundred hours, failures amounting to one diode and three dry joints.

Acknowledgment

Acknowledgment is made to the Directors and Mr. H. H. Galpin of Rank Cintel Ltd for permission to publish details of the oscillator.

REFERENCES

1. Owen, P. L., Partridge, M. F., Sizer, T. R. H. Corsair,, —. A Digital Differential Analyser. *Electrohic Engng. 32*, 740 (1960).
2. Owen P. L., Sizer, T. R. H. An Eight Digit Word Generator. *Electronic Engng. 32*, 134 & 212 (1960).

An 'On-line' Digital Computer Application

The first digital computer for the on-line control of an industrial process in the U.K. is now in operation at the Stocksbridge works of Samuel Fox & Co. Ltd.

This British steel manufacturer rolls billets of high quality steel to lengths of up to 450ft before cutting them to customers' requirements. Since the steel is largely to special order the billets must be cut to produce minimum wastage within the limits of the customers' specification and the length finally rolled. The problem is complicated by the layout of the mill which necessitates the use of cutting at two or three points.

The complete problem falls into four parts: first the measurement of billet length; second the calculation of optimum cutting points; third the transmission and display of this information to operators; and finally the recording of data for office purposes.

This problem has many aspects which indicate the great advantages that can be attained by the use of a digital computing system. The computation has to be fast enough not to hold up the billets on the track, a self-calibrating length measurement system is required and, since a number of billets can be on the track at the same time, considerable capacity for the storage of information is required.

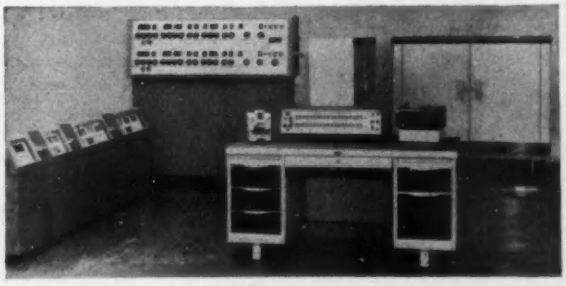
The joint study of this situation by Samuel Fox & Co. Ltd and E-A Automation Systems Ltd (a member of the Elliott-Automation Group), showed that there was ample economic justification for a computer to optimize the cutting at this point and an order for such a system was therefore placed. The system has been designed to include the Panellit 609 Information System which incorporates the Elliott 803 general-purpose computer.

The measurement of length is obtained by a self-calibrating pulse-counting system which compensates for the wear on the mill rolls. The presence or absence of the billet being detected by Lead Sulphide detectors which have the correct spectral response to detect even the billets which have been delayed at an earlier stage of rolling and have therefore cooled to 400 or 500°C. This detecting system and its enclosure was specially designed by E-A Automation Systems Ltd for this application.

The customers' order is set-up on a panel controlled by the Mill Foreman. This method of input was chosen in order to maintain the personal responsibility of the Foreman for the running of the mill. The order may specify for the final billet a fixed length, a limited continuous range or a range consisting of a series of steps. The computer must calculate the optimum cutting points to satisfy the customers' requirements within the mill operating conditions and also make allowance for the required test pieces as well as making statistical allowances for the variability of the stops at each saw and shear. This calculation takes less than a second and the information for the operators to use in setting their shears is therefore available within one second of the billet leaving the final mill. Most of this information is, however, normally stored in the computer until it is called for by the operator.

Each operator has a display panel on which information relating to the billet that he is about to cut up is displayed following the operation of a demand button, and checks are provided in the computer to ensure that the billet the operator is cutting corresponds with the one displayed on his panel. This is only one of a comprehensive series of checks in the computer programme that ensure that any abnormalities in the operation of the system are rapidly detected and identified.

Equipment for the control system. The four small units on the left of the picture are the display pulpits which tell operators at the saws the length to which billets are to be cut. Next to them is the console on which order book information is set. The other two units in the background house the computer and associated equipment. In the foreground is the control console



Application of Boolean Notation to the Maintenance of Switching Circuits

By S. Alexander*

A method is proposed for the notation of switching circuits with special regard to its application in the drawing up of test and maintenance schedules. The system is based on Boolean algebra which is already used extensively for the design of switching circuits. Several examples, including a sample 'test schedule' are given.

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

WITH the increasing use of automatic control schemes involving extensive switching circuits, new methods and techniques have been evolved to assist the engineer in obtaining the best design to suit his requirements.

The basic mathematical tool used for this purpose is Boolean algebra—the fundamental concepts of which are presented elsewhere[1,2,3].

Once the working design has been worked out it is committed to schematic drawings, from which the detailed assembly and wiring diagrams are then developed. A major control scheme such as used in the remote control and programming of process or nuclear power plants can extend over dozens of wiring and assembly drawings. The number of relays and switching elements used may run into thousands, and as the complexity of the circuits increases it is virtually impossible to keep on one drawing all the variables that can affect the operation of any piece of equipment.

Usually the schematic drawings show the equipment in a de-energized state, from which it can be very tedious to obtain the sequence of operations required to operate any device. It usually requires a knowledge of the actual functioning of the system, and this knowledge might not always be available, especially to maintenance personnel. When it comes to testing the integrity of any particular circuit or to 'trouble shooting', continual reference to drawings and factual descriptions of the system can be time-consuming, laborious, and very uneconomical.

As a breakdown in one single contact or a short-circuit in any wire can have serious effects on the operation of the system, the swift localization of a fault is a highly desirable feature of any maintenance procedure.

The Boolean notation can be adapted for drawing up test or maintenance sheets, which should greatly facilitate checking the circuit of any device, and denoting the sequence of operations required to actuate that device.

Theory

As stated previously, the fundamental aid in the logical description of switching circuits is Boolean algebra, and before proceeding to the first example, the Boolean notation to be used will be explained.

(a) Relay coils, contactors, lamps and motors will be denoted by capital letters. This includes those switches, push-buttons and devices operated by external operations.

(b) Relay and switch contacts will be denoted by lower case letters.

(c) If a relay coil is denoted by capital letters, e.g. *SPF*, then *SPF* will denote the de-energized state, and *SPF* primed (*SPF'*) will denote the energized state. Contact *spf*-1 (contact 1 of relay *SPF*) will denote a normally open contact and *spf*-1 primed (*spf*-1') will denote a normally closed contact.

(d) A dot . or parenthesis ( ) placed between two elements is read as 'and', e.g. $a.b(a)(b)$ is read as elements a and b. A '+' placed between two elements is read as 'or', e.g., $M_1 + M_2$ is read as M_1 or M_2.

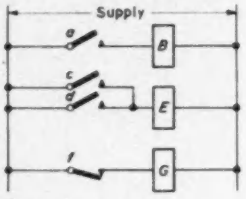


Fig. 1. Independent circuits

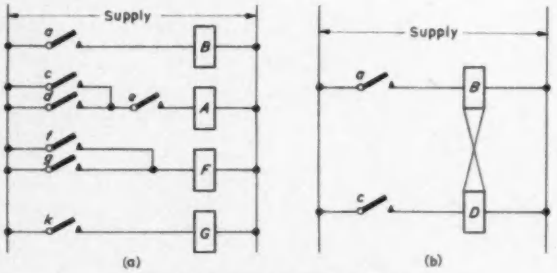


Fig. 2. (a) Sequential memory circuits (b) Latching memory circuits

Let network $n = (a + b)c$ be placed between the supply and a relay coil R. Then by making conventional use of Boolean equations to describe the open or closed condition of the network, one has

(1) $R = (a + b)c$ which is read:
the relay is energized ($= 1$) when $(a + b)c = n$ is equal to 1, i.e. when the contact configuration $(a + b)c$ is closed ($= 1$). This method of representation is suitable when only one relay is under consideration. When it comes to denoting several relays, which can be either dependent or independent of each other, the following notation is used to greater advantage.

(2) $T = R\,(a + b)c$.
This inserts the relay R in series with its own circuit. T is defined as the transmission of the circuit or as its 'transfer' function. If the circuit is closed and R is energized, the output voltage V_o/input voltage V_i is equal to 1; if the circuit is open $V_o/V_i = 0$. This

* *Atomic Power Projects, English Electric Co. Ltd.*

equation completely defines the circuit in that it tells from inspection under what condition the relay R is energized or de-energized.

Equation (2) assumes for n relay coils the following form

(3) $T = R_1n_1 + R_2n_2 + \ldots\ldots\ldots R_nn_n$

In sequential operations R_1 will be the final device operated, when n_1 is closed, and n_1 will be a function of R_2, n_2 of R_3, n_{n-1} of R_n and n_n is usually an independent device such as a switch.

Example 1—Independent Circuits (Fig. 1)

This serves as an illustration for showing all the devices that operate off one supply. All the relays and contacts are independent of each other.

$$T = Ba + E(c + d) + G f.$$

This is read as follows. The circuit is closed (= 1) when relay B is energized by contact a *or* relay E by contacts c or d *or* relay G via contact f.

Example 2—Sequential and Memory Circuits

The equation of the circuit in Fig. 2(a) is

$$T = Ba + A(c + d)e + F(f + g) + Gk$$

This is read in the same manner as in example 1 above, but because the terms A and a appear in two different terms separated by a '+', a sequence of operations is required before B can operate, i.e. A must first be energized before B can operate.

Whenever a relay appears in its own relay circuit, a memory circuit is implied. In the term $F(f + g)$, contact g must close to energize F, which then holds itself through its own contact.

In Fig. 2(b) there is a different type of memory circuit, in that the relay remains latched in its last operated position. The equation of this circuit assumes the following form

$$T = (B + D')a + (D + B')c$$

It must be noted that in this particular application once B or D is energized, it will stay operated even though contacts a or c may be open, i.e. the circuit may be open from an electrical point of view. In this case, even though the relay is not energized any more, it is still operated, and will be denoted with its designation primed.

Application to Maintenance Schedules

The previous examples have shown how it is possible to denote all the contacts, relays, contactors, etc, of a switching circuit, and their operation, by means of notation alone. This is usualy sufficient for the analysis and synthesis of the circuits involved. A breakdown in the circuit, however, might not involve the switching devices themselves, but fuses, wires, supply sources, plug and socket connexions, etc. The circuit concerned may be spread over the whole plant itself, with one relay in one cubicle and others in cubicles which can be hundreds of feet apart and in different rooms. Reference to drawings can be a very time-consuming and laborious process. If, however, every single element involved in a circuit is considered as a switch, the notation used above can be expanded to include these elements. Wires, fuses, plugs and sockets, can all be considered as switching elements which are normally closed; test and jack points as elements which are normally open (all these elements will be denoted by their unprimed designation). An example of this application follows.

Example 3 (Fig. 3)

A pressure test is initiated by depressing the 'pressure test' switch. Relay A is energized which picks up relay B. This starts a 30sec timer $T30$ after which period relay C operates, and energizes relay CV. Relay CV energizes the solenoid of valve V to close. When this valve closes it operates a limit switch VLS, which energizes relay VR.

A is de-energized and consequently relay B. This resets $T30$ and releases C.

PSR has been initially energized since the contacts of the pressure switch PS are normally closed, and open when the pressure rises to 2 lb/in².

Relay D is energized and starts a one minute timer $T1$, which after one minute closes contact $t1$-1 and energizes relay E which holds itself via e-1 and also energizes the indication 'pressure test complete' (if the pressure does rise above 2 lb/in² during the 1min period an alarm operates).

The system is reset by opening valve V. PS, LS, and the solenoid of V are remotely located, and are supplied by a multi-core cable which has a plug and socket arrangement between them and the relay cubicle. The mainten-

Pressure Test Complete Indication (Fig. 3)

	Remarks
$T =$ PRESSURE TEST COMPLETE INDICATION. line $J64$ (e - 1 + e - 1'. line $J61$. f - 1) line $J62$. fuse. 6V link. line $J63$.	
+ F on control desk. line $J51$. TEST ALL LAMPS PUSH-BUTTON. line $J52$. fuse. 50V. line $J53$	50V Supply Indication
+ E in Cubicle A Tray 5. line $K64$ ($t1$ - 1. line $K65$. psr - 1 + e - 1) line $K66$. vr - 2. line $K59$. fuse. 50V link. line $K58$.	
+ $T1$ in Timer Cubicle. line $H52$. d - 1. fuse. 110V. link. line $H54$.	110V a.c. Supply Indication
+ D in cubicle C tray 6. line $K65$. psr - 1. line $K66$. $v'r$ - 2. line $K59$. fuse. 50V. link. line $K58$.	
+ PSR in Cubicle B tray 5. plug and socket pin 39. ps. line $J71$. fuse. 50V. line $J72$.	
+ PS PRESSURE SWITCH ON COMPRESSOR OUTLET. PRESSURE BELOW 2 lb/in².	
+ VR in Cubicle B tray 6. plug and socket pin 36. vls. line $J71$. fuse. 50V d.c. link. line $J72$.	
+ VLS V closed Limit Switch. Valve V closed.	
+ Valve V Solenoid. plug and socket pin 35. OPEN V $P.B.'$. cv' - 1. line $J71$. fuse. 50V. link. line $J72$.	V Open Indication
+ (CV + OV') in Cubicle B tray 6. line $K62$. c - 1. line $K69$. PRESSURE TEST SWITCH. line $K59$. fuse. 50V. link. line $K58$.	
+ (OV + CV') line $K63$. OPEN V $P.B.$ line $K59$. fuse. 50V. link. Line $K58$.	
+ C Cubicle C tray 4. line $K68$. $t30$ - 1. line $K59$. fuse. 50V. link. line $K58$.	
+ $T30$ Timer Cubicle. line $H51$. b - 1. line $H53$. fuse. 110V. link. line $H54$.	
+ B Cubicle C tray 4. line $K67$. a - 1. line $K.59$. fuse. 50V. link. line $K58$.	
+ A Cubicle A tray 1. line $K61$. vr - 3'. line $K69$. PRESSURE TEST SWITCH. line $K59$. fuse. 50V. link. line $K58$.	
PRESSURE TEST ALARM	
$T =$ PRESSURE TEST ALARM, . line $C23$. psr - 2'. line $C24$. t 1 - 2. line $C21$. fuse. 50V. Battery link. line $C22$.	50V Battery Supply Indication

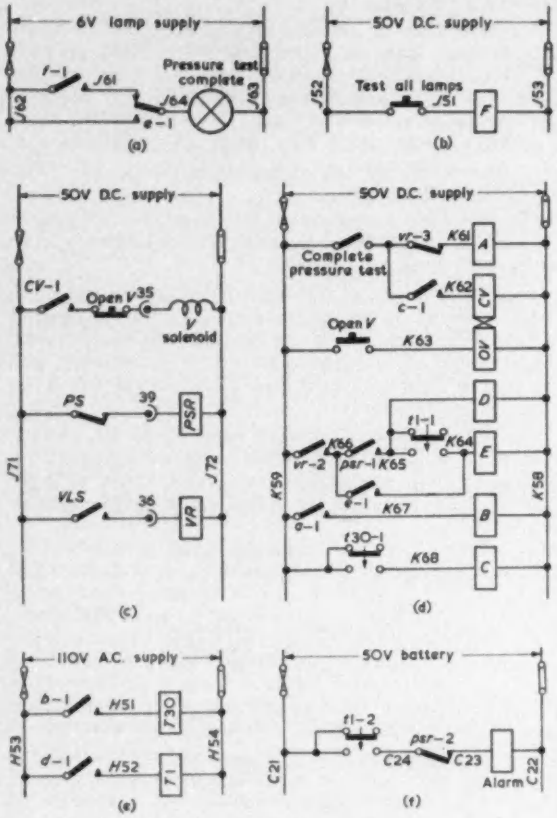


Fig. 3. Pressure test circuit

ance schedule for the control desk indication 'pressure test complete' would take the form given in Schedule 1.

As the schedule is drawn up, all the elements are denoted in their logical sequence. This is not absolutely necessary and other variations are possible. The common lines and supplies could be brought out as a common factor or made to fall under a particular column. As it is written, the end device to be operated always appears as the first term and then its network. Using this schedule the logical maintenance routine for checking the operation of the lamp, when it fails to operate (and the alarm has not operated), would be as follows:

(1) Operate the 'test all lamps' push-button.

(2) Check if 50V supply indication is energized.

(3) Check if 110V supply indication is energized.

(4) Check if *V*20 open indication not energized.

(5) The next step would be to check the relays, timers, limit and pressure switches either in their order of operation, or cubicle by cubicle as suits the particular circumstances.

It must be emphasized that the purpose of this example is to demonstrate the use of Boolean notation, and is not intended for practical design.

Conclusion

This type of schedule is very flexible and its use can greatly aid in the maintenance of the switching by personnel, who may be completely unfamiliar with its functional requirements. It can also be extended to the drawing up of operating instructions or to any type of system using two-state elements in its operation.

Acknowledgments

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REFERENCES

1. Keister, W., Ritchie, A., Washburn, S. The Design of Switching Circuits. (Van Nostrand, 1951).
2. Humphrey Jr., Watts, S. Switching Circuits with Computer Applications. (McGraw-Hill, 1958).
3. Caldwell, Samuel H. Switching Circuits and Logical Design. (Wiley & Sons. 1958).

A High Speed Flight Simulator

A pilot's ability to control a high performance aircraft in bad flying conditions can be tested by a new machine built for the Ministry of Aviation by the Precision Engineering Division of Short Brothers & Harland Limited, Belfast.

The machine, which will shortly be delivered to the Royal Aircraft Establishment, Bedford, is known as a Rocking Cockpit or, in full, a Flight Simulator Moving Cockpit Mechanism. It can move a complete aircraft cockpit just as it would move during high speed flight. For this reason it is considered a marked advance on conventional trainers which, being stationary, cannot give a pilot the sensation of being 'thrown around'.

The simulator consists of a heavy steel structure surmounted by a wide movable ram to which an aircraft cockpit will be attached. The arm, powered by two electric-hydraulic servos, can swing the cockpit up and down or tilt it from side to side—movements which correspond to pitch and roll in an aircraft. The cockpit will be equipped with standard flying controls which will enable the pilot to govern its attitude in the pitch and roll planes and thus 'fly' the simulator.

In simulated 'still air' conditions the cockpit will be completely under the control of the pilot, but to test his reactions in unfavourable flying conditions a specially built analogue computer will feed disturbances into the control system. The computer can be programmed to feed in any desired pattern of disturbances, causing the cockpit to move as it would in an aircraft flying through cross-winds, gusts, and turbulence. To keep the cockpit under control the pilot will then have to counteract the movements initiated by the computer. In other words he will 'fly' through these adverse conditions exactly as though he were in a real aircraft.

In the roll plane the cockpit can tilt to 15° from horizontal on each side at a maximum rate of 45°/sec. In pitch the limits are 20° above horizontal to 10° below, at maximum rate of 25°/sec. As the pilot is situated at the end of a swinging arm and is approximately six feet away from the pitch axis he can be swung through a large arc.

Because the rates of turn are high—the cockpit can go from horizontal to maximum tilt in any direction in less than one second—safety devices have been incorporated in the simulator's design. Special damping devices at the limits of the system's movement will overrule the pilot's commands should he make an error causing the cockpit to try to go beyond the maximum tilt. The safety mechanisms will also come into operation in the case of a runaway in the control circuits. Their function is to slow the system down when it nears maximum tilt, thus avoiding the excessive strain to both unit and pilot which would be the result of hitting the stops at speed.

A cockpit unit will be supplied by the R.A.E. and fitted to the simulator after delivery. But for the purpose of testing the machine Shorts have fitted a temporary pilot's seat and controls, with extra weights to represent the weight of the cockpit. The estimated weight of pilot and cockpit is over 700 lb, but the pitch servo motor is relieved of the overhanging moment loads by a balance ram acting on the underside of the swinging arm.

A Quick Method for Calculating Transistor Amplifier Circuits

By R. R. Vierhout* and A. J. H. Vendrik*

If the hybrid parameter h_{12} is neglected, as may be done for calculations in practice, the transistor can be treated as a current amplifier in a way analogous to the valve as a voltage amplifier. A useful quantity is the transfer impedance with which many characteristics of the circuits with feedback can be easily calculated. It is shown that an input impedance of several megohms is attainable with a special type of feedback.

Various ways of improvement of temperature stability of transistor circuits are discussed, which make use of a simple method of calculation. Formulae for noise in transistor circuits are derived.

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

CALCULATIONS of transistor circuit performance on the base of four-pole theory sometimes appear in the literature and lengthy formulae are produced, in which resistances of some 10Ω are summed with resistances of the order of 1MΩ and are then carried in this form through all derived calculations. These are difficult to memorize and give little insight in the behaviour of the circuits.

For practice an accuracy of 10 per cent is usually sufficient and the four-pole matrix can then be simplified by neglecting two of the four parameters. In this way expressions are obtained analogous to the Barkhausen formula for valve circuits. But one main distinction between transistors and valves must be emphasized, viz. that while valves are mostly treated as voltage amplifiers, it is more convenient to treat transistors as current amplifiers.

Voltage Amplifiers and Current Amplifiers

In practice, it is usually convenient to consider amplifiers as either voltage or current amplifiers. In the first case the input and output signals are expressed as voltages and in the latter as currents. The equivalent circuit of a voltage amplifier consists of a voltage generator in series with the output impedance. The output of this generator is μV_i, V_i being the input voltage and μ the voltage amplification factor. The equivalent circuit of a current amplifier has a current generator $\alpha' i_i$, i_i being the input current and α' the current amplification factor, in parallel with the same output impedance. For the voltage amplifier the ratio between the open circuit output voltage V_o and the input voltage V_i is μ, and for the current amplifier this ratio is $\alpha' r_o/r_i$. Hence both circuits are equivalent if one substitutes $\mu = \alpha' r_o/r_i$.

Whether an amplifier can be considered best as a voltage or a current amplifier depends on two properties. First it is most convenient to work with parameters which are not or almost not variable. The μ of valves is almost constant (i.e. independent of grid bias and thus signal voltage), while the μ of transistors varies considerably. On the other hand the current amplification factor α' of transistors is almost independent of base current bias.

Second, the magnitude of output and input impedance is of importance. If the input impedance is large with respect to the source impedance and the output impedance is small in comparison with the load impedance it is easier to make the calculations in the voltage form. However, if the input impedance is relatively small and the output impedance relatively large, the amplifier can be considered best as a current amplifier. The latter applies to transistors.

Figs. 1(a) and 1(b) show the equivalent circuit of a valve amplifier and a transistor amplifier respectively. For the sake of simplicity the impedances are shown as resistances. The input and output resistances are called R_i, r_i and R_o, r_o respectively. Often the reciprocal values of the resistances, the conductances will be used. They are denoted G or g. The arrows indicate the relative directions of the currents.

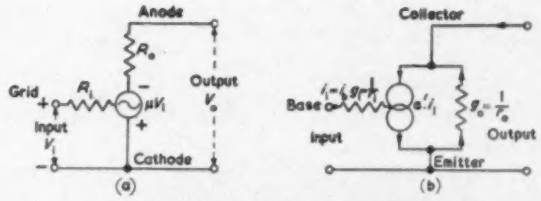

Fig. 1. (a) Equivalent circuit of a valve voltage amplifier (b) Equivalent circuit of a transistor current amplifier

The following figures illustrate the assertion that transistor amplifiers can be considered best as current amplifiers. For OC71: r_o has values ranging from 10 to 30kΩ, r_i is about 1 to 3kΩ, both depending on the base current bias, the current amplification factor α' is about 50 and fairly constant.

Transistor Characteristics and Parameters

Published transistor characteristics show that the base emitter voltage (V_{be}) is nearly independent of the collector emitter voltage (V_{ce}) at constant base current (i_b) for the curves are to a good approximation horizontal. This means that in the four pole equations (with hybrid matrix) for transistors:

$$V_{be} = h_{11} i_b + h_{12} . V_{ce}$$

$$i_c = h_{21} . i_b + h_{22} V_{ce}$$

in which i_c = the collector current, the parameter h_{12} is so small that it can be neglected for most applications, the more so if the load at the output is small (V_{ce} is small).

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It follows that $h_{11}=r_i$; $h_{12}=0$; $h_{21}=\alpha'$; $h_{22}=g_o$ in this conception. This simple behaviour of the current amplifier is based on the assumption that h_{12} can be neglected.

Fig. 2(a) gives the diagram of the connexions of a transistor for a.c. amplification. The leak R_b provides the base current bias. For a battery of 15V and a bias of 15μA, R_b must be about 1MΩ, because the base emitter resistance of the transistor for d.c. can always be neglected in comparison with R_b.

If one applies an alternating current signal at the input, part of this current goes through R_b and part of it through the base-emitter junction r_i. As $R_b \gg r_i$ the leak through R_b can be neglected. The input-signal gives rise to a current α' times greater in the transistor and it is desired that as much as

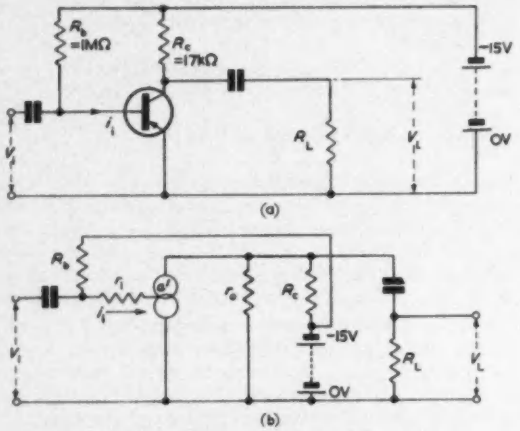


Fig. 2. (a) An a.c. amplifying stage with an OC71
(b) Equivalent circuit of Fig. 2(a)

possible of this current flows through the load R_L. Therefore, R_c is as big as possible without making V_{ce} too small. For the OC71 a good choice is $R_c = 17k\Omega$. The collector emitter voltage will then be $-3V$. Fig. 2(b) shows the equivalent circuit on which the calculations will be based.

Calculations

The current source has an output of $-\alpha' . i_i$ Amperes. The voltage across R_L is then:

$$V_L = \frac{-\alpha' . i_i}{(1/r_o)+(1/R_c)+(1/R_L)} = \frac{-\alpha' . i_i}{g_o + G_c + G_L} \quad \ldots\ldots\ldots\ldots (1)$$

the g's and G's are the conductances, i.e. the reciprocal values of the resistances.

The current through R_L is:

$$i_L = \frac{-\alpha' . i_i . G_L}{g_o + G_c + G_L} \quad \ldots\ldots\ldots\ldots (2)$$

The source current is nearly equal to i_i, because $R_b \gg r_i$. Therefore, the current amplification is:

$$i_L/i_i = \frac{\alpha' . G_L}{g_o + G_c + G_L} \quad \ldots\ldots\ldots\ldots (2a)$$

and the transfer impedance is:

$$V_L/i_i = W = \frac{\alpha'}{g_o + G_c + G_L} \quad \ldots\ldots\ldots (1a)$$

The term transfer impedance means the ratio between V_L and i_i, which has the dimension of an impedance and which is very convenient for the calculations if the voltage at the output of the last stage is required.

It will be seen that the two resistances r_o and R_c of about 17kΩ give a resulting resistance of about 8kΩ. Therefore the current amplification is about $0{\cdot}9 . \alpha' = 0{\cdot}9 \times 60 = 54$ when $R_L = 1k\Omega$ which is the input resistance of the next transistor stage.

Also it is important to have low input-resistances (R_L), i.e. high input conductances (G_L) for transistors in order to obtain a high current amplification, equation (2a).

In Fig. 3(a) another circuit is drawn; the emitter-follower which is analogous to the cathode-follower of the valve circuit.

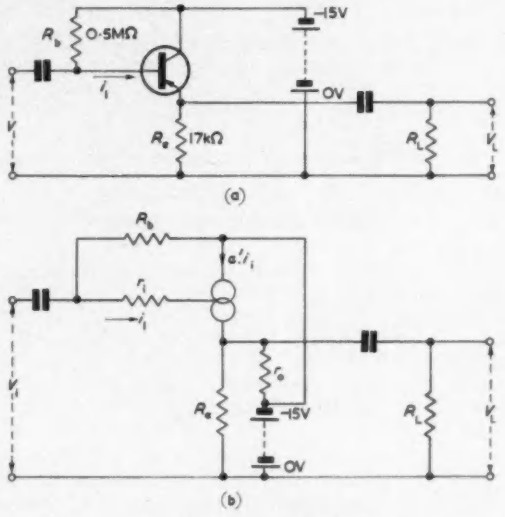


Fig. 3. (a) The emitter-follower
(b) Equivalent circuit of Fig. 3(a)

As may be observed in Fig. 3(b) the equivalent of Fig. 3(a), the current amplification is:

$$i_L/i_i = \frac{(1+\alpha') . G_L}{G_L + g_o + G_e} \simeq \frac{\alpha' . G_L}{G_L + g_o + G_e} \quad \ldots\ldots\ldots\ldots (2b)$$

Hence the current amplification is about the same as for the circuit of Fig. 2(a). Only, the current through R_L is in phase with the input current, while the current through R_L of the circuit of Fig. 2(a) is 180° out of phase with the input current. The emitter-follower is a useful method of obtaining stages without phase shift and with amplification, which sometimes is needed for feedback.

It follows from equation (2b) that the transfer impedance is:

$$V_L/i_i = W = \frac{(1+\alpha')}{G_L + g_o + G_e} \quad \ldots\ldots\ldots (1b)$$

The voltage V_1 is opposed by the voltage V_L at the other side of the input resistance r_i. Therefore the voltage across r_i is:

$$i_i r_i = V_1 - V_L = V_1 - i_i W \quad \ldots\ldots\ldots (3)$$

and therefore:

$$V_1/i_i = r_i + W = r_i + \frac{(1+\alpha')}{(1/R_L)+(1/r_o)+(1/R_e)} \quad \ldots\ldots\ldots\ldots (4)$$

This ratio between applied input voltage and input current is the effective input resistance. Equation (4) shows that this is the resistance r_i in series with the parallel resistances r_o, R_e and R_L multiplied by $(1+\alpha')$. This can be

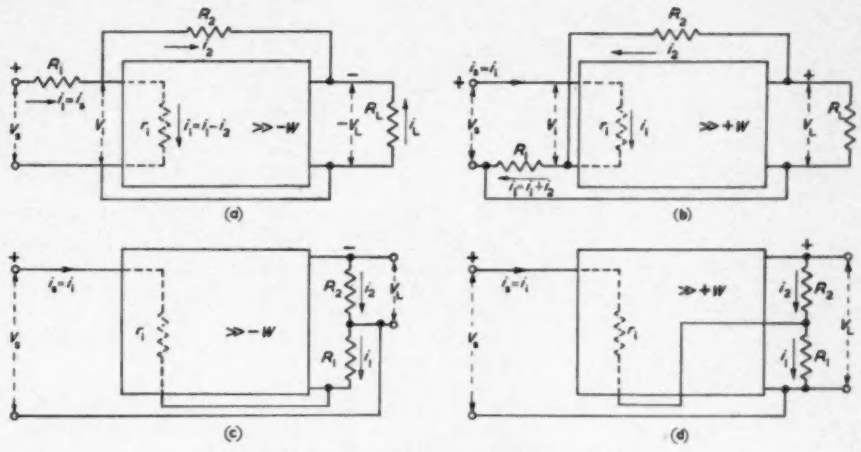


Fig. 4. Four simplified types of feedback connexions

explained by considering that the current i_i evokes a $(1 + \alpha')$ times greater current at the resistance $1/[(1/r_o) + (1/R_e) + (1/R_L)]$, hence a $(1 + \alpha')$ times greater counter voltage as might be expected if the current i_i was flowing only through this resistance. Therefore, this resistance must be multiplied by $(1 + \alpha')$ to get the effective resistance, 'seen' at the input side of the transistor. Practically, if $R_e > 10\text{k}\Omega$ and R_L is not greater than $1\text{k}\Omega$, r_o and R_e may be neglected and with $\alpha' = 50$ the effective input resistance is about $50 \cdot R_L$ in series with r_i.

Then:

$$V_L = \frac{W}{r_i + W} \cdot V_i \simeq \frac{\alpha' \cdot R_L}{r_i + \alpha' \cdot R_L} \cdot V_i \simeq V_i$$

This can be seen directly because the resistances r_i and W in series form a voltage divider with V_L across W.

Analogous to the cathode-follower the voltage at the output is almost equal to the voltage at the input. The output-impedance is the resistance R_L' which halves the output voltage V_L with infinite load impedance. From the last formula it appears that $R_L' = r_i/\alpha$ or about $1000/50 = 20\Omega$. Hence, the emitter-follower has a low output impedance, if the source impedance (in series with r_i) may be neglected. Resuming the properties of the emitter-follower: the input resistance is great (α' times the load at the emitter), the output impedance is small (r_i/α'), the voltage amplification is nearly 1 and the current amplification is the same as for the ordinary circuit of Fig. 2(a), i.e. great.

For reasons of simplicity the base current bias is supplied directly by the battery via the resistance R_b. However, this gives a poor temperature stability which will be explained later.

Feedback

There are several ways to introduce feedback in an amplifier, but all these feedback connexions can be reduced to one of four types, shown in Fig. 4, viz. current and voltage negative feedback both with and without phase reversal of the amplifier. The types of Fig. 4(b) and 4(d) are essentially the same.

Fig. 4(a) shows a current amplifier with phase reversal, the transfer impedance being negative: $-W$. A resistance R_2 connects the output to the input.

In this case R_1 includes the source impedance. It is assumed that $R_1 \gg r_i$, the input impedance of the current amplifier, and that $W \gg r_i$, which is almost always the case. Then the transfer impedance of the amplifier with feedback is:

$$V_L/i_s = V_L/i_1 = \frac{V_L}{i_1 + i_2} = \frac{V_L}{V_L/W + V_L/R_2} = \frac{1}{1/W + 1/R_2} \quad \ldots\ldots\ldots\ldots (5)$$

The feedback resistor R_2 changes the transfer impedance W of the circuit without feedback to the parallel impedance of W and R_2. If $W \gg R_2$, then the transfer impedance of the circuit with feedback is practically determined by R_2 and independent of the drift of the current amplification factor of the amplifier.

The voltage at the input of the amplifier is:

$$V_i = (i_1 - i_2)\, r_i = [i_1 - (V_L/R_2)]\, r_i = \left(i_1 - \frac{i_1}{1 + R_2/W}\right) r_i = i_1/[(1/r_i) + (W/r_i) \cdot (1/R_2)]$$

Hence the effective input impedance of the amplifier is:

$$V_i/i_1 = \frac{1}{(1/r_i) + (W/r_i) \cdot (1/R_2)} \quad \ldots\ldots\ldots (6)$$

or equal to the impedance of the parallel connexion r_i and the impedances $R_2 \cdot (r_i/W)$, i.e. an impedance R_2, which is transformed by the amplifier to an impedance W/r_i times smaller, parallel to r_i. W/r_i is the voltage amplification as easily can be shown. The input impedance is decreased by the feedback.

If the internal resistance of the last stage is R_e and the total current amplification of the preceding stages multiplied by the current amplification factor of the last stage is A, then (see equation (1a)):

$$W = \frac{A}{G_o + G_L + G_2}$$

when $G_o = 1/R_e$, $G_L = 1/R_L$ and $G_2 = 1/R_2$.

According to equation (5):

$$V_L/i_s = \frac{1}{G_2 + (G_o + G_L + G_2)/A} = \frac{A}{(1 + A)\, G_2 + G_o + G_L} \quad \ldots\ldots\ldots\ldots (7)$$

The denominator of equation (7) shows that if G_L increases from zero to the value $G_o + (1 + A)\, G_2$, then the value of V_L is halved. Hence, the output impedance of the circuit is composed of the parallel connexion of R_e and $R_2/(A + 1)$, which impedance is lowered considerably by feedback.

It is seen that the output impedance is changed by the feedback as if the resistance $R_2/(A + 1)$ is connected parallel to R_L and R_e. Then equality (7) results.

If the circuit of Fig. 4(a) is considered as a current amplifier (for the input impedance is extremely low) it

follows from equation (7):

$$i_L/i_s = \frac{V_L \cdot G_L}{i_s} = \frac{G_L}{G_2+(G_2+G_o+G_L)/A} \simeq R_2/R_L \quad \ldots\ldots\ldots\ldots \text{(7a)}$$

This equality is valid, if A has such a large value that the second term in the denominator can be neglected.

Fig. 4(b) shows a current amplifier without phase reversal. The feedback resistor R_2 is now connected to the other side of the input. The following equalities are valid:

$$\left.\begin{aligned} V_s &= i_s(r_1 + R_1) + i_2R_1 \\ V_L &= i_s \cdot R_1 + i_2(R_2 + R_1) \\ V_L &= i_1 \cdot W = i_s \cdot W \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \text{(8)}$$

Calling $(R_2 + R_1)/R_1 = \gamma$ one obtains from equation (8) the effective input impedance:

$$V_s/i_s = r_1 + \frac{R_1 \cdot R_2}{R_1 + R_2} + W/\gamma \quad \ldots\ldots\ldots\ldots \text{(9)}$$

and the voltage amplification:

$$V_L/V_s = \frac{\gamma}{1 + \dfrac{r_1 + \dfrac{R_1R_2}{R_1 + R_2}}{W/\gamma}} \quad \ldots\ldots\ldots\ldots \text{(9a)}$$

Equation (9a) shows that the voltage amplification is nearly equal to γ with a stability factor against fluctuations in W of the amplifier of about $(r_1 + R_1)/(W/\gamma)$, if $R_2 \gg R_L$.

W/γ has the dimension of an impedance. According to formula (9), the resistance R_1 is increased by the feedback with W/γ. If W/γ is 100kΩ and $r_1 + R_1$ is of the order of 1kΩ, the stability factor amounts to 1:100, which is considerable. In transistor amplifiers one can easily attain transfer impedances of several megohms, with one transistor about ¼MΩ, with two transistors about 10MΩ etc. Hence both the stability and the input impedance can be increased considerably, sacrificing the voltage amplification γ.

In formula (9) the effective input impedance has a value of about W/γ, neglecting r_1 and R_1. Now, if the value of W/γ increases beyond 0·5MΩ the effective input impedance does not increase much more. The reason for this behaviour is shown in Fig. 5. Because the feedback current through R_2 is proportional to the input current and hence to the current, generated by the first transistor, R_1 provides a high impedance seen from the input because both the feedback current through R_1 and the transistor current of the first stage flow through R_1, and these currents are much larger than the input current. As far as the input impedance is concerned one could replace R_1 by a high impedance and disconnect the feedback.

But parallel to this high impedance is R_b and the internal impedance of the first transistor in series with the input impedance of the second transistor (heavy lines in diagram). In the last mentioned impedance a current flows which is nearly 50 times greater than the input current, hence this impedance is 'seen' 50 times higher at the input side of the first transistor which yields a value of about 50 × 15kΩ = ¾MΩ. This last value limits the attainable input impedance.

However, these considerations do not hold for the circuit of Fig. 4(a). The input impedance of this circuit will be about R_1, if a high resistance R_1 is put between the connexion point and the source. The voltage amplifiation is then $\frac{WR_2/(W + R_2)}{R_1}$.

Again substituting $W = A/(G_o + G_2 + G_L)$ in formula (9a), the output impedance of the circuit of Fig. 4(b) becomes:

$$\frac{1}{(1/R_o) + (1/R_2)\left(1 + \dfrac{A}{1 + \gamma \cdot r_1/R_2}\right)} \quad \ldots\ldots \text{(9b)}$$

The output impedance is lowered, but slightly less than is the case with the circuit of Fig. 4(a).

Fig. 4(c) shows another kind of feedback with a current amplifier with phase reversal. Formulae (8) again are valid for this type of feedback. Also formulae (9), (9a) and (9b) are valid. Extremely high input impedances can be attained by sacrificing some of the voltage amplification, because the internal resistance of the first stage does not lie parallel to the input.

Fig. 4(d) shows feedback with an amplifier without phase reversal. This is another way of drawing Fig. 4(b), hence the two circuits are the same. The same remarks, concerning the input impedance, are valid. With the circuits of Figs. 4(c) and 4(a) higher input impedance can be obtained than with the circuits of Figs. 4(b) and 4(d), because on the latter the input impedances are limited by the internal collector base resistance of the first stage. The circuit of Fig. 4(c) is to be preferred to 4(a) because in the latter the high resistance R_1 introduces much thermal noise.

Frequency Response of the Transistor

The amplification factor of a transistor decreases above the so-called cut-off frequency with a slope of about 6dB/octave. This attenuation is due to a limited mobility of the carriers in the barrier region, their diffusion and recombination properties.

This can be described by a capacitance connected across the input which takes away part of the current. The cut-off frequency f_α of the OC71 is about 6kc/s in the common emitter connexion as dealt with here.

Furthermore, an additional phase shift exists of nearly 12°/octave at frequencies larger than the cut-off fre-

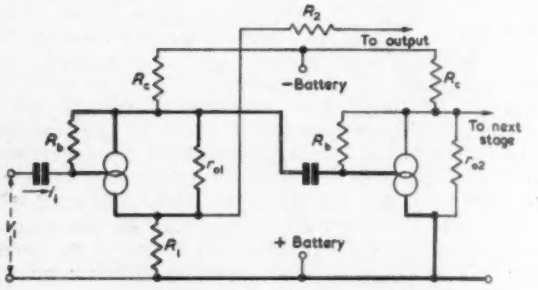
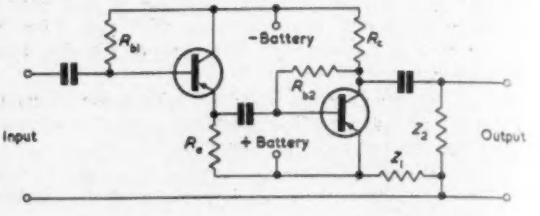


Fig. 5. The input introduced in R_1 by feedback is limited by the shunt indicated by the heavy lines

Fig. 6. The circuit which guarantees a high input impedance by feedback



quencies. The bandwidth of 6kc/s is broadened by feedback in the circuits of Fig. 4.

The imaginary capacitance has a value, which depends on r_i, because the cut-off frequency has a determined value. Due to the phase shift, feedback over more than two transistors is extremely difficult, and suitable attenuation

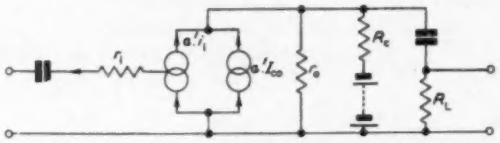


Fig. 7. An extra current generator $\alpha' . I_{co}$ is responsible for the temperature drift of the operating point

filters should be included in the circuits to prevent oscillation at frequencies over 6kc/s. Feedback over two transistors is possible.

To obtain an input impedance of more than 1MΩ the circuit of Fig. 4(c) must be used. To obtain the necessary phase reversal the circuit must be designed as in Fig. 6. By sacrificing the amplification an input impedance of 5MΩ can be easily obtained. The following stages must provide the amplification.

Details have been published[1], of a millivoltmeter with a high input impedance according to the considerations detailed above.

The Effects of Temperature and Noise

It was shown that for many important applications transistor amplifiers can be best treated as current amplifiers neglecting the hybrid parameter $h_{12} \equiv (\partial V_{be}/\partial V_{ce})_{i_b} = \text{constant}$, i_b being the base current and V_{be} and V_{ce} the base-emitter voltage and the collector-emitter voltage respectively. By doing so the calculations are much simpler than the elaborate ones mostly used and the formulae can be easily understood, while the error introduced by this omission is, for most purposes, sufficiently small.

In the circuits discussed so far no attention has been paid to temperature stability and noise. In the following these two properties of transistor circuits will be considered as they are obviously very important and frequently transistor circuits are published which are not optimally designed in this respect.

Temperature Dependency of the Operating Point

According to the characteristics of the OC71, the collector current at zero base current is nearly $-200\mu A$. It is a collector current which may be generated by a base current of $-200/50 = -4\mu A$. The latter is called the 'cut-off current' (I_{co}) of the transistor. In this manner this extra current is 'translated' to the base side. If the temperature of the transistor rises, the whole set of lines of constant base current moves nearly the same distance upwards. The shift is about 8 per cent of the instantaneous value, i.e. the above mentioned $200\mu A/°C$. Translated to the base-side: the cut-off current increases $0{\cdot}08 \times 4 = 0{\cdot}32A/°C$. Fig. 7 gives the equivalent circuit of this extra current. It is an extra current source with strength $\alpha' . I_{co}$ parallel to the amplifier current source.

Hence, if the temperature rises, this extra current increase flows through the collector resistance R_c and causes a decrease in the collector emitter voltage. It is necessary that the collector emitter voltage remains larger than 0·25V, even at the highest working temperature. Therefore R_c may not be chosen too high. If the cut-off current increases by ΔI, the d.c. collector-emitter voltage decreases by $W_{dc} . \Delta I$, if W_{dc} is the transfer impedance for d.c. signals. According to formula (1a):

$$W_{dc} = \frac{\alpha'}{g_c + g_e} \quad \ldots\ldots\ldots\ldots \quad (10)$$

Thus one can calculate the temperature effect on V_{ce}. On the other hand some d.c. feedback can be applied to diminish this temperature effect.

In Fig. 8(a) the base leak R_b is tied to the collector point, instead of to the battery. This causes a decrease of the base current if the collector emitter voltage has the tendency to decrease and hence the collector current has the tendency to increase less than without feedback. Formula (5) shows the new transfer impedance with R_b as feedback resistance.

$$W_{dcfb} = \frac{1}{1/W_{dc} + 1/R_b} \quad \ldots\ldots\ldots\ldots \quad (10a)$$

Or, as shown previously, in the equivalent circuit a resistance $R_b/(1 + \alpha')$ is in parallel with r_o (see Fig. 8b). With this decreased transfer impedance one can calculate the temperature influence on V_{ce} for the OC71. If $R_c = r_o = 17k\Omega$ and $V_{ce} = -3V$, then R_b must be about 200kΩ to give a base current of $-15\mu A$. The transfer impedance is now: $W_{dcfd} = 60/(1/17 + 1/17 + 61/200)\,k\Omega = 142k\Omega$. Then V_{ce} decreases by $142 \times 0{\cdot}32 = 45mV/°C$. Without feedback it would decrease $0{\cdot}32 \times 60/(1/17 + 1/17) = 163mV$. The temperature stability is increased by a factor $S_T = 163/45 = 3{\cdot}6$.

Now the feedback resistor R_b decreases the current amplification somewhat, viz. by the factor: $(1/17 + 1/17 + 1/1 + 61/200) : (1/17 + 1/17 + 1/1) = 1{\cdot}27$ if $R_{L(ac)} = 1k\Omega$.

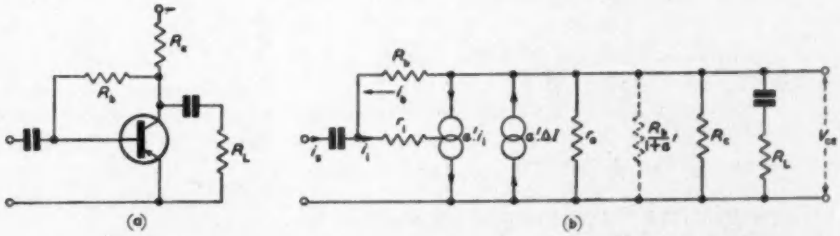


Fig. 8. (a) The collector-base leak R_b which gives the base current bias, stabilizes the operating point (b) The resistance R_b, introducing negative feedback, has the same action as a shunt $\frac{R_b}{1+\alpha'}$ across the output

Another way to counteract temperature-effects is given in Fig. 9(a). Here the emitter-resistance gives a feedback effect for the d.c. signals. The decoupling capacitance opposes the feedback effect for the a.c. signals. With the resistances R_{b1} and R_{b2} the voltage between base and common is more or less fixed, more so when these resistances are low, less if they are higher.

If an increase in temperature evokes an increase in cut-off current, then the voltage across R_e increases. Because the d.c. voltage of the base is held nearly constant by the voltage divider R_{b1}, R_{b2}, the voltage between base and emitter decreases. Thus, the base d.c. bias decreases, which opposes the increase of the cut-off current.

From Fig. 9(b) one obtains for the collector emitter voltage V_{ce} with d.c. feedback:

$$V_{cefb} = \frac{\alpha' \Delta I}{1/r_o + \frac{1}{R_e + R_c} \cdot \frac{r_i + R_b + (\alpha' + 1)R_e}{r_i + R_b + R_c R_e/(R_c + R_e)}} \quad \ldots\ldots\ldots\ldots (11)$$

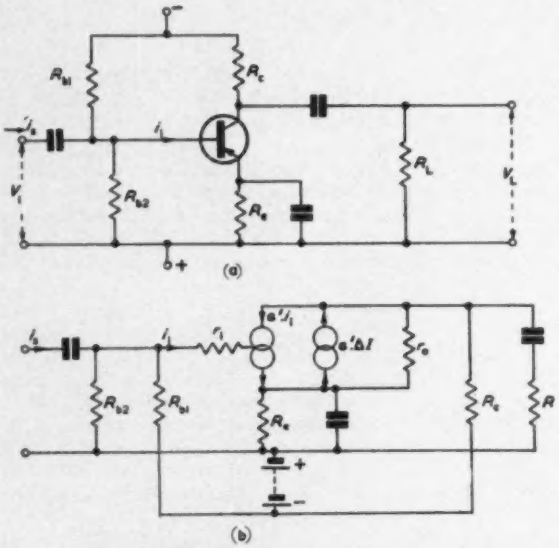


Fig. 9. (a) Stabilizing the operating point by an emitter resistance R_e (b) Equivalent circuit of Fig. 9(a)

Because $R_c \gg R_e$ this can be approximated to:

$$V_{cefb} = \frac{\alpha' \Delta I}{1/r_o + \frac{1}{R_e + R_c}\left[1 + \alpha' \cdot \frac{R_e}{R_e + r_i + R_b}\right]} \quad \ldots\ldots\ldots\ldots (11a)$$

In the equalities (11) and (11a) $R_b = R_{b1} \cdot R_{b2}/(R_{b1} + R_{b2})$ and r_i is the input impedance of the transistor.

If $R_e = 0$, the collector-emitter voltage without temperature stabilization is:

$$V_{ce} = \frac{\alpha' \cdot \Delta I}{1/r_o + 1/R_c} \quad \ldots\ldots\ldots\ldots (12)$$

From equation (11a) it follows that the lower R_b the better is the temperature stabilization.

For a.c. input signals a decrease in transfer impedance by the by-pass of current through R_b exists. The transfer impedance is lowered by a factor $R_b/(R_b + r_i)$. By making $R_c = 17\text{k}\Omega$ and $r_o = 17\text{k}\Omega$, for $R_b = 4\text{k}\Omega$ and for $R_e = 0{\cdot}5\text{k}\Omega$, then the a.c. transfer impedance is lowered by a factor $4/5 = 1/1{\cdot}25$ which is nearly equal to the factor in the former kind of stabilization.

The stabilization factor $V_{ce}/V_{cefb} = [1/17\,(2 + 60\ 0{\cdot}5/5{\cdot}5)]/(2/17) = 3{\cdot}73$. The stabilization is also about the same as in the former circuit for stabilization. To achieve a better a.c. transfer impedance (say with a loss of only 10 per cent instead of 20 per cent) it is necessary to choose R_b about two times higher and also R_e two times higher.

Hence, it is seen that a better a.c. transfer impedance is obtained with the same temperature stability with emitter feedback than with the collector base feedback. However, a resistance of 1kΩ in the emitter lead and with, for example, 16μF as a by-pass makes a high pass filter with a cut-off frequency of 10c/s.

For an amplifier for very low frequencies, the collector base bias resistance must be used as a temperature stabilizer.

Noise

The noise, generated by a transistor, is due to the various semiconductor and surface conduction processes and can be represented by a noise voltage generator V_{tr} and a noise current generator I_{tr} at the input, as in Fig. 10.

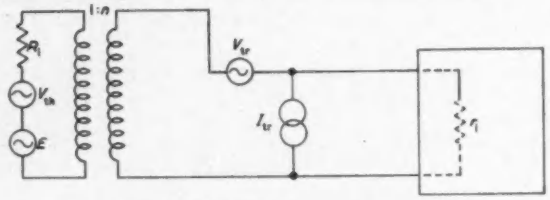


Fig. 10. The noise generators at the input

Assuming that an ideal transformer with winding ratio $1:n$ is connected between a source of voltage E and source impedance R_i which has a noise voltage V_{th}, and the transistor, the maximum value of the signal-to-noise ratio can be calculated. The square of the signal voltage at the input of the transistor is equal to:

$$E^2 \cdot n^2 \cdot \left(\frac{r_i}{r_i + n^2 \cdot R_i}\right)^2 \quad \ldots\ldots\ldots\ldots (13)$$

The square of the noise voltage, originating from the transistor and the source impedance R_i is equal to:

$$V_{tr}^2 \left(\frac{r_i}{r_i + n^2 \cdot R_i}\right)^2 + I_{tr}^2 \left(\frac{r_i \cdot n^2 \cdot R_i}{r_i + n^2 \cdot R_i}\right)^2 + C \cdot R_i \cdot n^2 \left(\frac{r_i}{r_i + n^2 \cdot R_i}\right)^2 \quad \ldots\ldots\ldots\ldots (13a)$$

if $V_{th}^2 = C \cdot R_i$ and if C is a constant, which has the value of $1{\cdot}6 \times 10^{-20}\,(f_2 - f_1)\ \text{V}^2/\Omega$ at room temperature. f_2 and f_1 are the upper and lower 'effective'† frequencies respectively of the transistor circuit. Hence, the signal-to-noise ratio is:

$$\frac{E^2 \cdot n^2}{V_{tr}^2 + I_{tr}^2 \cdot n^4 R_i^2 + C \cdot R_i \cdot n^2} = \frac{E^2}{(V_{tr}^2/n^2) + I_{tr}^2 \cdot R_i^2 \cdot n^2 + C \cdot R_i} \quad \ldots\ldots\ldots\ldots (14)$$

It follows from equation (14) that the signal-to-noise ratio has a maximum value if n satisfies the equality:

$(V_{tr}^2/n^2) = n^2 \cdot I_{tr}^2 \cdot R_i^2$ or: $n^2 \cdot R_i = (V_{tr}/I_{tr}) = R^*$ .. (15)

$R^* = V_{tr}/I_{tr}$ is mentioned in the documentation of the transistor as the 'optimum impedance'. If the source impedance is matched by means of the transformer to the optimum impedance R^*, then the signal-to-noise ratio is a maximum. Noise data are derived from measurements, generally made with the source impedance made equal to

† *'Effective' means that the (amplitude-ratio)²-frequency response curve is replaced by a rectangle of the same area with unit height. The lower and upper limit of this rectangle are the 'effective' frequencies.*

R^*, which appears in most cases to be nearly equal to the input impedance r_i of the transistor (i.e. 500 to 1 000Ω). These noise data include, besides the value of R^*, the 'noise factor' F. The noise factor is the ratio between the total noise power P_{tr}^*, generated by the transistor and the source impedance $R_i = R^*$ and the noise power P_{th}^*, generated by the thermal noise of R^*alone. Hence:

$$F = \frac{P_{tr}^* + P_{th}^*}{P_{th}^*}$$

The square of the noise voltage of R_i is equal to (see equation (13a)):

$$V_{th}^2 = C \,.\, R_i \,.\, n^2 \left(\frac{r_i}{r_i + n^2 \,.\, R_i}\right)^2 = C \,.\, R^* \left(\frac{r_i}{r_i + R^*}\right)^2 \quad \ldots\ldots\ldots\ldots (16)$$

if the source impedance is properly matched.

The square of the noise voltage of the transistor, appearing at the input, for optimal match, is equal to (see equations (13a) and (15)):

$$\left(\frac{r_i}{r_i + R^*}\right)^2 (V_{tr}^2 + I_{tr}^2 \,.\, R^{*2}) = \left(\frac{r_i}{r_i + R^*}\right)^2 . 2V_{tr} \,.\, I_{tr} \,.\, R^* \quad \ldots\ldots\ldots\ldots (16a)$$

Hence, according to the definition of F:

$$F - 1 = (P_{tr}^*/P_{th}^*) = \frac{2V_{tr} \,.\, I_{tr} \,.\, R^*}{C \,.\, R^*} = (2/C) \,.\, V_{tr} \,.\, I_{tr} \text{ or:}$$

$$V_{tr} \,.\, I_{tr} = (C/2)(F - 1) \quad \ldots\ldots\ldots\ldots (17)$$

with:

$$V_{tr}/I_{tr} = R^* \quad \ldots\ldots\ldots\ldots (15a)$$

$$V_{tr}^2 = C \,.\, R^* \,.\, \frac{F - 1}{2} \text{ and } I_{tr}^2 = (C/R^*) \,.\, \frac{F - 1}{2} \quad \ldots\ldots\ldots\ldots (17a)$$

Note: Sometimes in the documentation a noise figure is mentioned which is given in decibels and is equal to $10^{10} \log F$ (sometimes the noise figure is erroneously indicated as noise factor).

From the noise data F and R^* it is possible to calculate the square of the noise voltage in series with the input of the transistor V_N^2 for an improperly matched circuit. If the source is connected directly to the input of the transistor the square of the noise voltage can be calculated from equation (13a) by substituting $n = 1$. The square of the noise voltage V_N^2 is equal to:

$$V_N^2 = V_{tr}^2 + I_{tr}^2 \,.\, R_i^2 = C \,.\, \frac{F - 1}{2} \,.\, R_i \,[(R^*/R_i) + (R_i/R^*)] \quad \ldots\ldots\ldots\ldots (18)$$

The term between brackets of equation (18) is a minimum for $R_i = R^*$. Then:

$$V_N^2 = C(F - 1) \,.\, R^* \quad \ldots\ldots\ldots\ldots (18a)$$

$F - 1$ for the OC71 is of the order of 10.

The noise factor F is dependent on frequency and it appears that $F - 1$ follows the $1/f$ law for low frequencies. It is not entirely certain that $F - 1$ follows this law for very low frequencies, but this is not important for a.c. amplifiers.

For frequencies above about 2kc/s for the OC71 (dependent on the individual transistor) the noise factor remains independent of frequency up to the frequency:

$$f_{\alpha'} \sqrt{(1 + \alpha')} \simeq 6 \sqrt{50} \simeq 42\text{kc/s}$$

Above this frequency the noise increases linearly with the frequency. In the following the band is considered to have an upper frequency lower than this.

F is measured at 1kc/s and may be called F_o. Hence $F - 1 = 1\,000.\,(F_o - 1)/f$ for frequencies < 2kc/s. Then from equation (18) the following expression is obtained for the noise voltage in series with the input for frequencies less than 2kc/s.

$$V_{N1}^2 = 1{\cdot}6 \times 10^{-20} \times 1\,000 \,\frac{F_o - 1}{2} R_i (R^*/R_i + R_i/R^*) \int_{f_1}^{f_2} df/f =$$

$$0{\cdot}8 \times 10^{-17} (F_o - 1) R_i (R^*/R_i + R_i/R^*) \ln f_2/f_1) = 1{\cdot}84 \times 10^{-17} (F_o - 1) (R_i (R^*/R_i + R_i/R^*) \log (f_2/f_1) \text{ volts}^2 \quad \ldots\ldots (19)$$

for a matched source impedance.

$$V_{N1}^2 = 3{\cdot}68 \times 10^{-17} (F_o - 1) R^* \log (f_2/f_1) \; (= 2V_{tr}^2) \quad \ldots\ldots (19a)$$

In a d.c. amplifier f_1 must be replaced by the inverse maximum period of observation. For the OC71 : $F = 10$ and $R^* = 500\Omega$. Hence, for a band ranging from 0·2c/s to 2kc/s, according to equation (19a) $V_{tr} = 0{\cdot}58\mu$V and $I_{tr} = 0{\cdot}58/500 = 1{\cdot}2 \times 10^{-3}\mu$A. For frequencies above 2kc/s:

$$V_{N2}^2 = 1{\cdot}6 \times 10^{-20} \;(1\,000/2\,000) \,.\, \frac{F_o - 1}{2} R_i (R^*/R_i + R_i/R^*)$$

$$(f_2 - 2\,000) = 0{\cdot}8 \times 10^{-17} (F_o - 1) R_i (R^*/R_i + R_i/R^*) [(f_2/2000) - 1]$$

For a band ranging from 2kc/s to 20kc/s the factor $(f_2/2\,000) - 1$ becomes 9 and hence is about equal to $\log (2000/0{\cdot}2) = 9{\cdot}2$.

Therefore $\sqrt{(V_{N1}^2 + V_{N2}^2)} = 0{\cdot}82\mu$V.

For a band ranging from 2kc/s to 200kc/s the noise V_{N2}^2 becomes predominantly greater than V_{N1}^2, hence the calculation of V_{N1} may be omitted.

If, in a circuit with feedback (e.g. the circuit of Fig. 4(c)), the influence of the current-generator I_{tr} must be annulled by the signal source, then this signal must give rise to a current I_{tr} in the circuit with R_i and R_1 in series, in the same direction of the current I_{tr}. Only in that case, there will be no voltage difference over r_i and there will be no current in r_i and no output voltage V_o. Then, E, the signal, must have a value $E = I_{tr}(R_i + R_1)$. The noise is then equivalent to a noise voltage generator of $I_{tr}(R_i + R_1)$ volts, a noise generator V_{tr} and a noise generator, originating from the resistors R_i and R_1 of $\sqrt{[C(R_i + R_1)]}$ in series with the signal generator. From the above it follows that the noise of I_{tr} becomes very powerful if the source impedance or the feedback impedance R_1 in the input is large. Therefore, it is better to apply feedback instead of putting a high resistor in series with the input, if a high input impedance is desirable, because R_1 is relatively small.

The thermal noise of a series resistor increases with the root of the resistance, but the noise, generated by I_{tr} increases linearly with the resistance.

If $R_i = 0$ and R_1 is of the order of 1kΩ then the noise will be: (OC71; 0·2c/s to 20kc/s):

$$V_N^2 = 0{\cdot}82^2 + 1{\cdot}7^2 + 0{\cdot}57^2 = 1{\cdot}97^2 (\mu\text{V})^2$$

The noise of the current generator is even in this favourable case, predominant.

For comparison the noise of a circuit without feedback with the same high input impedance of 1MΩ obtained by means of a series resistor:

$$V_N^2 = 0{\cdot}82^2 + 1{\cdot}7^2 \times 1\,000^2 + 0{\cdot}57^2 \times 1\,000 (\mu\text{V})^2 \simeq 1{\cdot}7^2 (\text{mV})^2$$

REFERENCES

1. Vierhout, R. R. An A.C. Transistor Millivoltmeter with a High Input Impedance. *Electronic Engng. 32*, 435 (1960).
2. Becking, A. G. Th. Groendijk, H. Knol, K. S. The Noise Factor of Four Terminal Networks. *Philips Res. Rept. 10*, 349 (1955).
3. Keonjian, E., Schaffner, J. S. An Experimental Investigation of Transistor Noise. *Proc. Inst. Radio Engrs. 4*, 1457 (1952).
4. Hibberd, F. Transistor Noise Factors Calculations. *Electronic Engng. 32*, 163 (1960).

A Transfer Function Analyser for Linear and Non-Linear Components

By A. K. Choudhury*, M. S. Basu* and A. K. Mahalanabis*

This article describes a method of measuring the frequency response, gain and phase of linear and non-linear physical components. The method requires only standard resistors and capacitors and such other accessories as are easily available in an electronics laboratory and permits good accuracy over a wide frequency range starting from extremely low values. Results of measurements on some non-linear characteristics are presented.

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

THE frequency response method of analysis is finding increasing use in the study of linear and non-linear physical systems (electrical, mechanical, hydraulic, pneumatic etc.), notably, in the field of feedback control systems. For linear components, excitation with sinusoidal input functions produces a sinusoidal output and the component transfer function is simply the ratio of the output and input both expressed in phasor forms. For non-linear components a sinusoidal excitation produces a periodic but non-sinusoidal output which, in general, contains a fundamental as well as higher order harmonics. In feedback control systems analysis the non-linearity is approximated by an equivalent quasi-linear transfer function. This equivalent transfer function of the non-linearity is usually known as its 'describing function' and is defined as the ratio of the fundamental component of the output to the sinusoidal input, both being again expressed in phasor forms.

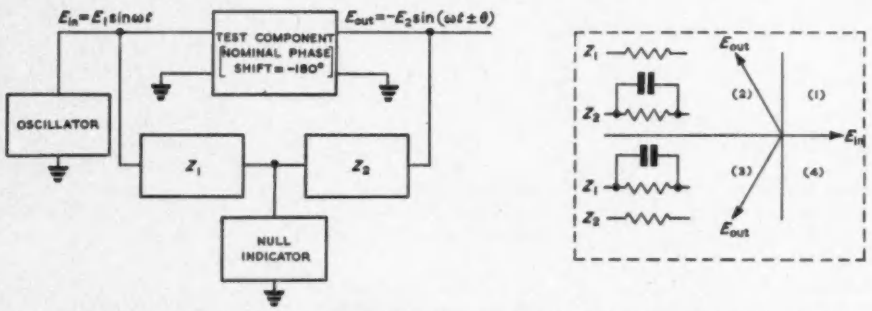


Fig. 1. A system for measuring the transfer functions of linear components having nominal phase-shift of 180°

A variety of instruments and techniques is available at present for the determination of transfer functions of both linear and non-linear components from extreme low frequencies to moderately high frequencies[1-3].

A new method of measurement that permits determination of the transfer functions of both linear and non-linear components is described in the present article. Test results on the transfer functions of a number of non-linearities obtained by this method are compared with theoretical values. Finally the limitations of the method and also its advantages and disadvantages are discussed in relation to other available methods.

Theory and Method of Measurement

The arrangement for measurement of the transfer function is shown in Fig. 1. The measuring circuit consists of two impedance elements Z_1 and Z_2 and a suitable sensitive null indicator connected between the junction of Z_1 and Z_2 and the ground terminal. For measurements of linear transfer functions the null indicator may simply be a suitable meter or, preferably, a sensitive oscilloscope. The null indicator will then read zero when:

$$(E_{out}/E_{in}) = |G|\,e^{j\phi} = -(Z_2/Z_1) \quad \ldots\ldots\ (1)$$

For measurement of transfer functions at very low and moderately high frequencies Z_1 and Z_2 are preferably composed of R and C elements. A balance can be obtained by proper choice of Z_1 and Z_2 when the phase of the output voltage lies within the range 90° to 270° lagging with respect to the input voltage. For example, if Z_1 is purely resistive and Z_2 a parallel combination of R and C, then for balance it is essential that the lagging phase-angle of the output voltage lies between 180° to 270°. If, however, Z_2 is purely resistive and Z_1 a parallel combination of R and C the phase-lag of the output voltage must lie between 90° to 180°. It is therefore seen that for setting up the bridge only one fixed resistor, one variable resistor and a variable capacitor is necessary.

If Z_1 is a fixed resistor R_1, and Z_2 is a parallel combination of a variable resistor and capacitor and if under the condition of balance, the values of the variable resistor and capacitor are respectively R_2 and C_2, the transfer function gain and phase shifts are given by:

$$|G|\,e^{j\phi} = -(R_2/R_1)\,\frac{1}{1+j\omega R_2C_2} \quad \ldots\ldots\ (2)$$

i.e.:

$$|G| = (R_2/R_1)\,\frac{1}{\sqrt{(1+\omega^2R_2^2C_2^2)}} \quad \ldots\ldots\ (3)$$

and:

$$\phi = \pi - \tan^{-1}\omega R_2C_2 \quad \ldots\ldots\ (4)$$

If on the other hand Z_2 is a fixed resistor R_2', and Z_1 is a parallel combination of resistance and capacitance, and if R_1' and C_1' be the values of these components under the condition of balance, then:

$$|G|\,e^{j\phi} = -(R_2'/R_1')\,(1+j\omega R_1'C_1') \quad \ldots\ldots\ (5)$$

i.e.:

$$|G| = (R_2'/R_1')\,\sqrt{(1+\omega^2R_1'^2C_1'^2)} \quad \ldots\ldots\ (6)$$

and:

$$\phi = \pi + \tan^{-1}\omega R_1'C_1' \quad \ldots\ldots\ (7)$$

As stated above, the above arrangements permit measurements only when the output vectors lies in the 2nd or 3rd

* Institute of Radio Physics and Electronics, University of Calcutta.

quadrants. If, however, the output lies in the 1st or 4th quadrant, it is only necessary to place an invertor after the test unit and follow a similar precedure. This is represented in Fig. 2.

If the system under test is composed of a non-linear element, the output of the system, when excited by a sinusoidal input, will contain the fundamental frequency and its harmonics. The describing function of the non-linear

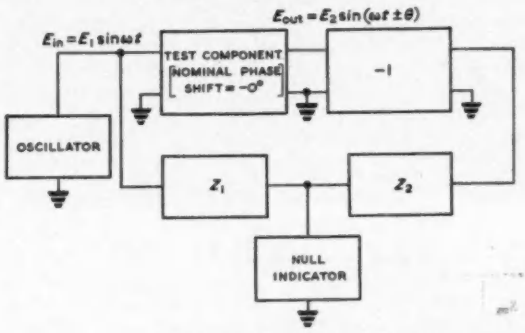


Fig. 2. Modification required for components having nominal phase-shift of 0°

element can be readily measured by adjusting the bridge for null at the fundamental frequency. To achieve this, a low-pass filter ensuring a suitable rejection ratio between the higher order harmonics and the fundamental is made use of so that only the fundamental is effective in actuating the null-detector.

A Practical Circuit Arrangement

The Measuring Circuit

The circuit arrangement used for measuring transfer functions with lagging phase shifts of units having a nominal phase shift of 0° is shown in Fig. 3. Here Z_1 is a resistance, R_1 and Z_2 consists of a parallel combination of resistance R_2 and capacitance C_2. R_2 and C_2 are variable in steps of 10Ω and 10pF respectively. According to relation (2) the fundamental component transfer function is:

$$|E_{21}/E_1|\, e^{-j\phi} = (R_2/R_1)\frac{1}{1 + j\omega R_2 C_2} \quad \ldots\ldots (6)$$

Magnitude of the transfer function is:

$$|E_{21}/E_1| = \frac{R_2}{R_1\sqrt{(1 + \omega^2 R_2^2 C_2^2)}} \quad \ldots\ldots (7)$$

and the angle of the transfer function is:

$$\phi = \tan^{-1}\omega R_2 C_2 \quad \ldots\ldots (8)$$

The transfer function corresponding to any value of the input signal amplitude and frequency is obtained by finding the values of R_2 and C_2 that give null indication; equations (7) and (8) then give respectively the magnitude and angle of the relevant transfer function.

The Filter

The filter circuit used in Fig. 3 is shown in detail in Fig. 4. The circuit has a second order transfer function:

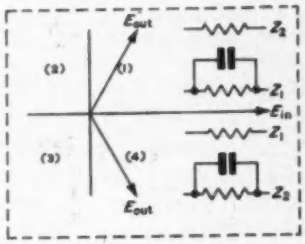
$$A = \text{Out/In} = \frac{b}{(j\omega)^2 + a(j\omega) + b}$$

$$= \frac{1}{1 + 2\xi(j\omega/\omega_o) + (j\omega/\omega_o)^2} \quad \ldots\ldots (9)$$

This is plotted in Fig. 5 for different values of the damping parameter ξ. It is seen that for small values of ξ the response characteristic shows a pronounced peak about:

$$\omega = \omega_o = \sqrt{b} \quad \ldots\ldots (10)$$

and then drops off at a rate which depends on the exact value of ξ. If the frequency ω_o is chosen equal to the frequency of the input signal it follows that the circuit in Fig. 4 will accentuate the fundamental to the exclusion of the harmonics. If the non-linearity in the test component is symmetrical, as is most common in control systems, then only odd harmonics are generated at its output. In the circuit of Fig. 4 if ξ is set at 0·1 the third harmonic (which is incidentally nearest to the fundamental in this case) will be transmitted at about 30dB below the fundamental while the next nearest frequency, i.e., the fifth harmonic will be transmitted at more than 35dB below the fundamental. It can then be concluded that barring cases where non-linearity produces such high distortion that the harmonics become comparable to the fundamental the output of the circuit in Fig. 4 will contain mostly signal of the fundamental frequency with a small amount of the third harmonic (and fifth harmonic in the worst cases).



The Indicator

The indicator used in Fig. 3 is a low frequency cathode-ray oscilloscope. A meter is not suitable in this case since, as mentioned in the previous section, some amount of third order harmonic will generally be present at the filter output so that zero deflexion is not obtained even when the fundamental component balances the input. With the cathode-ray oscilloscope the balance condition for the fundamental is, however, readily detected.

In regions quite off the balance the fundamental frequency component predominates and a precise sine wave of the fundamental frequency is displayed. As the balance condition is gradually approached the fundamental component diminishes and when it becomes comparable with the third harmonic the cathode-ray tube displays a periodic but the familiar non-sinusoidal waveform produced by the superposition of the third harmonic on the fundamental.

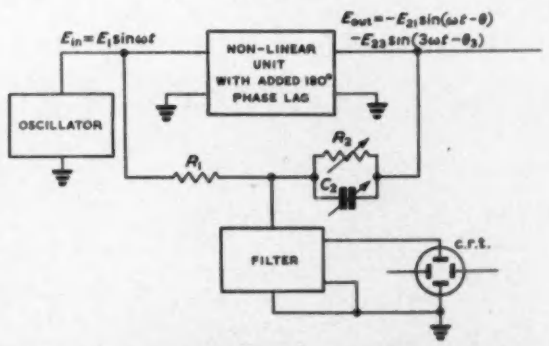


Fig. 3. A practical circuit arrangement for measuring transfer functions of non-linear components with nominal phase-shift of 0°

However, when the exact balance condition for the fundamental is reached the cathode-ray tube will display the third harmonic alone, i.e. a sine wave of frequency three times the fundamental.

Some Test Results

As has been mentioned previously the circuit in Fig. 3 has been used for testing some non-linear function generators. This has been done by measuring the transfer functions of the relevant non-linearities and then checking the measured values against the theoretical results. The non-linearities tested in this way include simple non-linearities such as saturation and coulomb friction and multiple valued non-linearity such as backlash hysteresis. These data are presented in Tables 1 to 3. A look at the Tables will indicate that the measured values of gain or magnitude in all cases agree with the theoretical values to within a maximum variation of 5 per cent. The phase-angles for the backlash non-linearity agree with the theoretical values to within 1·4°.

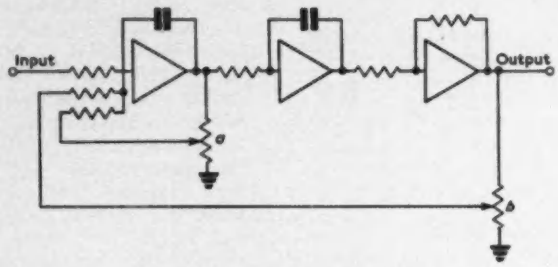


Fig. 4. The filter circuit used in Fig. 3

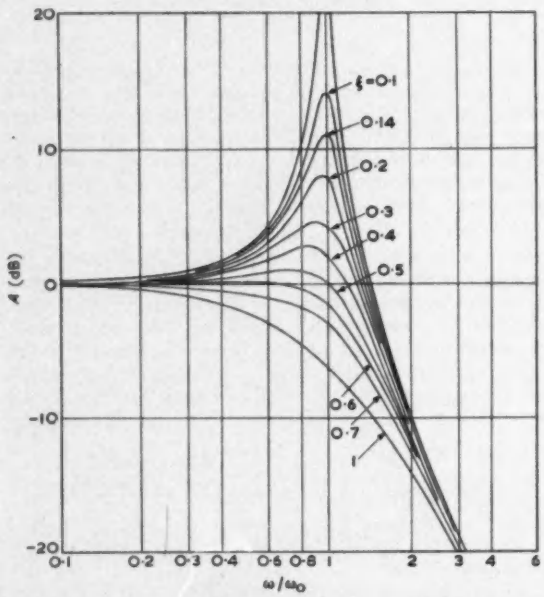


Fig. 5. The non-dimensional frequency response curves of the filter in Fig. 4

The deviations of the measured values from the theoretically computed values are attributable to two distinct sources: (a) errors in measurement, and (b) errors in generation of the non-linear function. An attempt will now be made to estimate the probable errors in the proposed method of measurement.

Sources of Errors

The method as outlined is not free from errors. The main sources of error inherent in the method are: (1) tolerance in available *RC* component values, (2) presence of higher order harmonics due to non-ideal filtering.

Tolerance in Values of Available *RC* Components

In measuring the transfer functions given in Tables 1 to 3 R_1 was chosen as 1MΩ with 1 per cent tolerance and R_2 and C_2 were decade units variable within 1·111110MΩ to 0·000001MΩ and 1·111110μF to 0·000001μF respectively. Both R_2 and C_2 could be set correct to the fourth place of decimals. This will be clear from the photographs of the displays in Figs. 6(a) to 6(d). In Fig. 6(a) is shown a c.r.t. display when R_2C_2 are quite off the balance. In Fig. 6(b) is shown the trace under condition of balance. In Figs. 6(c) and 6(d) are shown traces when respectively R_2 and C_2 are changed by 0·2 per cent and 0·3 per cent from the condition in Fig. 6(b). Thus, the errors in measurements arising from the sensitivity of the set up in

TABLE 1
Transfer Function of Saturation Characteristics

θ_s/θ_m	TRANSFER GAIN			TRANSFER ANGLE		
	CALCULATED	MEASURED	DEVIATION (per cent)	CALCULATED (degrees)	MEASURED (degrees)	DEVIATION
0·1	0·127	0·124	2·5	0	0	—
0·2	0·253	0·250	1·25	0	0	—
0·3	0·376	0·360	4·5	0	0	—
0·4	0·495	0·485	2·5	0	0	—
0·5	0·608	0·607	0·2	0	0	—
0·6	0·715	0·702	1·8	0	0	—
0·7	0·810	0·789	2·5	0	0	—
0·8	0·895	0·862	2·5	0	0	—
0·9	0·962	0·929	3·4	0	0	—

θ_s = *Saturating level*
θ_m = *Amplitude of input sine signal*

TABLE 2
Transfer Function of Coulomb Friction

C/θ_m	TRANSFER GAIN			TRANSFER ANGLE		
	CALCULATED	MEASURED	DEVIATION (per cent)	CALCULATED (degrees)	MEASURED (degrees)	DEVIATION
0·1	0·124	0·130	4·8	0	0	—
0·2	0·248	0·251	1·2	0	0	—
0·3	0·372	0·387	4·0	0	0	—
0·4	0·496	0·517	4·0	0	0	—
0·5	0·620	0·649	4·0	0	0	—
0·6	0·744	0·764	2·8	0	0	—
0·7	0·868	0·906	4·2	0	0	—
0·8	0·992	1·020	3·0	0	0	—
0·9	1·116	1·160	3·6	0	0	—

C = *Coulomb friction torque constant*

TABLE 3
Transfer Function of Backlash

δ/θ_m	TRANSFER GAIN			TRANSFER ANGLE		
	CALCULATED	MEASURED	DEVIATION (per cent)	CALCULATED (degrees)	MEASURED (degrees)	DEVIATION
0·1	0·931	0·971	4·3	− 6·6	− 7·60	+1·00
0·2	0·880	0·896	1·8	−13·2	−14·20	+1·00
0·3	0·792	0·807	1·9	−19·4	−20·55	+1·15
0·4	0·696	0·713	2·4	−25·6	−26·85	+1·25
0·5	0·592	0·605	2·1	−32·5	−33·00	+0·50
0·6	0·480	0·498	3·7	−38·8	−39·70	+0·90
0·7	0·367	0·379	3·2	−46·0	−47·10	+1·10
0·8	0·247	0·258	4·4	−54·6	−56·00	+1·40

δ = *Backlash half width*

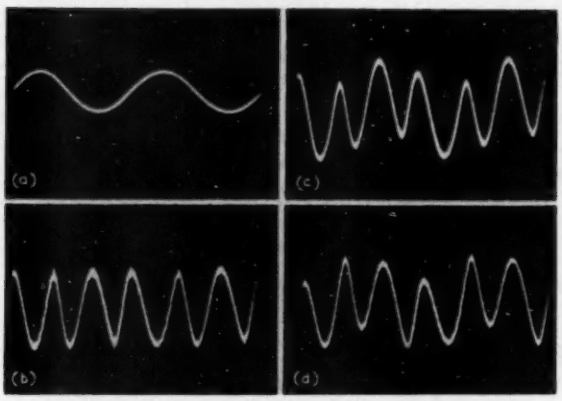


Fig. 6. Some typical displays of the c.r.t. traces

(a) When variable resistor and capacitor (R_2-C_2) are set at values quite off the balance condition, (b) when R_2-C_2 are set for the balance, (c) when R_2 is changed from the value in (b) by 0·2 per cent keeping C unchanged, and (d) when C is changed from the value in (b) by 0·3 per cent keeping R_2 unaltered

Fig. 3 can be neglected being only in the fourth place of decimals. However, the imposition of a finite tolerance in the *RC* component makes the measured values of gain and phase liable to error.

It can be shown that a tolerance of 1 per cent in the *RC* values can cause a maximum error of 2 per cent in the gain and a maximum error in the phase of about 0·9° at a phase-angle of 45°, assuming 1 per cent error in the frequency settings.

Presence of Harmonics

Presence of the higher order harmonics at the filter output makes null adjustments difficult and time consuming. However, the amount of the harmonics at the filter output is easily controlled by adjusting the damping parameter and a sufficiently accurate null detection can always be ensured. In Fig. 6, for example, the damping coefficient was set at $\xi = 0{\cdot}05$ and, as explained earlier the null condition could be set accurately to the fourth place of decimals.

Conclusion

The method permits measurement of transfer gains and phase angles over a wide range of values from extreme low frequencies to moderately high frequencies. It has the great advantage of requiring only standard resistors and capacitors and such other accessories as are easily available in any electronics laboratory. As against other direct indicating systems the method has the merit of giving somewhat more accurate results, being essentially a null indicating device.

One serious operational disadvantage in making measurements with frequency dependent components is the setting of the filter at each frequency. This can, however, be overcome by ganging up the filter with the driving oscillator.

Acknowledgment

The authors take this opportunity to express their gratitude to Professor J. N. Bhar, D.Sc., F.N.I., Ghose Professor of Physics and Head of the Institute of Radio Physics & Electronics and Professor S. K. Mitra, F.R.S., Emeritus Professor of Physics, Calcutta University, for their very kind interest in the work.

One of the authors (Mahalanabis) is thankful to the Ministry of Scientific Research & Cultural Affairs, Government of India, for financial assistance.

References

1. Burns, D. O., Cooper, C. W. A Harmonic Response Testing Equipment for Linear Systems. *Proc. Inst. Elect. Engrs. 100*, Pt. 2, 213 (1953).
2. Collins, D. J., Smith, J. E. Measurement of Small Phase Shifts with a Phase Sensitive Voltmeter. *Electronic Engng. 30*, 146 (1958).
3. Collins, D. J., Smith, J. E. Some Method of Phase Measurement Used in Transfer Function Analysis. *Electronic Engng. 30*, 182 (1958).

An E.H.T. Generator for Space Research

The Bristol Aircraft Limited, a company of the British Aircraft Corporation, has designed for the Space Research Group at University College, London, an e.h.t. generator to be used in the Anglo-American space research satellite, UK Scout 1.

In upper atmosphere and space research, proportional gas counter tubes are used to detect radiation in the X-ray region. These tubes require a highly stable supply of around 1·6kV. In short-term experiments, such as those carried out with the upper atmosphere probe, the Skylark rocket, this voltage is generally supplied by dry batteries.

For satellite experiments, however, where the equipment is operating for perhaps a year, dry batteries are not stable enough and have an intolerably large temperature coefficient. Bristol Aircraft has therefore designed an e.h.t. generator for University College, London, to replace dry batteries.

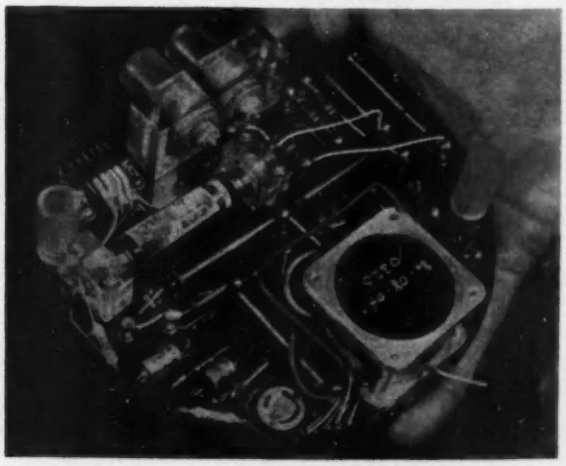
The generator supplies 1·6kV, stabilized by a corona stabilizer tube to within 1·5V of this level, against a primary supply change of ±15 per cent about 6·5V. The output from a single transistor oscillator, working at about 8kc/s, is stepped up by a transformer and voltage quadrupler, rectified and smoothed, the ripple amplitude on the output being less than 0·005 per cent. The power consumption of the unit is about 80mW from the nominal 6·5V supply.

The current through the stabilizer tube is telemetered to obtain a measure of the output voltage, as it would be inconvenient to measure the 1·6kV directly.

The unit is housed on a 5¼in diameter board, the components being coated with polysulphide rubber before encapsulation in foamed resin to a depth of one inch. The foamed resin successfully suppresses corona discharge from high potential points during the launch phase while the pressure is being reduced to the vacuum in orbit. The potted unit is screened by a copper-coated top board and an edge screen of copper foil.

The unit has been satisfactorily tested over the pressure range from 1 atmosphere to 0·3 micron of mercury.

The e.h.t. generator for the UK Scout 1 research satellite



LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

The Development of the *h*-Parameter Formulae Using Matrices

DEAR SIR,—As is well known the *h*-parameter formulae constitutes a useful method of analysing simple transistor networks. The development of these formulae is a little tedious; the following attack using Matrix algebra yields the results in a quick and straightforward manner.

For small signal applications the general characteristics of a transistor may be represented by the following group of equations where V_1, V_2, I_1 and I_2 are small audio frequency signals and

h_{11} = input impedance for constant output voltage.

h_{12} = voltage feedback ratio for constant input current.

h_{21} = current amplification factor for constant output voltage.

h_{22} = output admittance for constant input current.

$$\left.\begin{aligned} V_1 &= h_{12}V_2 + h_{11}I_1 \\ -I_2 &= h_{22}V_2 + h_{21}I_1 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (1)$$

The negative sign is given to I_2 in order that the equations are consistent with conventional matrices. Equation (1) may be conveniently written

$$\begin{bmatrix} V_1 \\ -I_2 \end{bmatrix} = \begin{bmatrix} h_{12} & h_{11} \\ h_{22} & h_{21} \end{bmatrix} \begin{bmatrix} V_2 \\ I_1 \end{bmatrix} \quad \ldots\ldots (2)$$

For the development of *h*-parameter formulae it is necessary to consider the corresponding *A* matrix. This is given by equation (4), this having been developed utilizing the *a* parameters shown in equation (3) in conjunction with equation (1).

$$\left.\begin{aligned} V_1 &= a_{11}V_2 + a_{12}I_2 \\ I_1 &= a_{21}V_2 + a_{22}I_2 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (3)$$

$$[A] = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} = -\begin{bmatrix} \dfrac{|h|}{h_{21}} & \dfrac{h_{11}}{h_{21}} \\ \dfrac{h_{22}}{h_{21}} & \dfrac{1}{h_{21}} \end{bmatrix} \quad \ldots\ldots (4)$$

Note $|h| = h_{11}h_{22} - h_{12}h_{21}$

In practice the load is included within the general matrix; to be more precise the load current would not be given by I_2 in equation (3) but by V_2 in conjunction with the known load. It is seen that I_2 which flows away from a closed network is zero, thus from equation (3).

$$V_1 = a_{11}V_2 \quad \ldots\ldots\ldots\ldots (5)$$

$$I_1 = a_{21}V_2 \quad \ldots\ldots\ldots\ldots (6)$$

The simple amplifier shown in Fig. 1 can now be considered. With the load R_L equation (4) is modified to read

$$[A_{RL}] = -\begin{bmatrix} \dfrac{|h'|}{h_{21}'} + \dfrac{h_{11}'}{h_{21}'R_L} & \dfrac{h_{11}'}{h_{21}'} \\ \dfrac{h_{22}'}{h_{21}'} + \dfrac{1}{h_{21}'R_L} & \dfrac{1}{h_{21}'} \end{bmatrix} \quad \ldots\ldots\ldots\ldots (7)$$

It is now possible to develop the simple formulae. As is usual with a grounded emitter stage the *h*-parameters have been primed to indicate the connexion.

From equation (5) (and suitably transcribing the notation) in conjunction with equation (7)

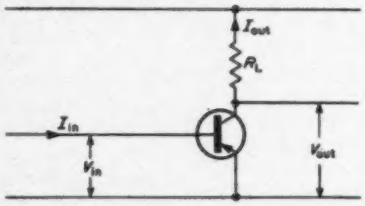


Fig. 1. Elementary grounded emitter amplifier

$$\text{Voltage gain} = 1/a_{11} = -\left(\frac{|h'|}{h_{21}'} + \frac{h_{11}'}{h_{21}'R_L}\right)^{-1} = \frac{-h_{21}'}{|h'| + h_{11}'G_L} \quad \ldots\ldots\ldots\ldots (8)$$

Note $G_L = 1/R_L$

Now $I_{out} = V_{out}/R_L$

Hence from equation (6)

$$\text{Current gain} = -1/a_{21}R_L = \left[\left(\frac{h_{22}'}{h_{21}'} + \frac{1}{h_{21}'R_L}\right)R_L\right]^{-1} = \frac{h_{21}'G_L}{h_{22}' + G_L} \quad \ldots\ldots\ldots\ldots (9)$$

From equations (8) and (9)

$$\text{Power gain} = \frac{(h_{21}')^2 G_L}{(h_{11}'G_L + |h'|)(h_{22}' + G_L)} \quad \ldots\ldots (10)$$

Dividing equation (5) by equation (6)

Input impedance, Z_{in}

$$= \frac{|h'|R_L + h_{11}'}{h_{22}'R_L + 1} = h_{11}\frac{h_{12}'h_{21}}{h_{22}' + G_L} \quad \ldots\ldots\ldots\ldots (11)$$

The output impedance is dependent upon the source resistance (R_S) and may be shown to be

$$Z_{out} = \frac{a_{12} + a_{22}R_S}{a_{11} + a_{21}R_S} = \frac{h_{11}'R_S}{|h'| + h_{22}'} \quad \ldots\ldots\ldots\ldots (12)$$

These formulae have all been developed from the grounded emitter connexion; for use in the grounded base or grounded collector connexions it is only necessary to substitute the appropriate numerical values for the *h*-parameters as the formulae are perfectly general and do not in themselves require modification. Care should be taken to observe the sign attributed to the transistor current gain in the connexion considered.

Yours faithfully,

J. S. BELL,

Elizabeth East,
South Australia.

A Frequency Measuring Receiver

DEAR SIR,—Mr. Meakes' article, 'A Frequency Measuring Receiver', which appeared in the November 1960 issue implies that only one signal will be within the i.f. pass-band of the receiver and that a carrier will be present. Both of these assumptions are often invalid especially if it is necessary to listen to the signal using a wide bandwidth—at the same time as measuring its frequency. An obvious refinement would be a twin channel 100kc/s i.f., one channel for monitoring or identification purposes and the other adjustable to a narrower bandwidth for frequency measurement.

Where the signal lacks a clearly defined carrier, the visual beat indicator will be of little help but a useful indication of its frequency, accurate to within a fraction of the i.f. bandwidth, could still be obtained by tuning the receiver using the narrowest 100kc/s i.f. bandwidth possible and ensuring the i.f. is accurately aligned and symmetrical.

When one has an i.f. of this nature a further use is immediately apparent, that of using the counter to accurately tune the receiver to a particular frequency.

Any experience the author has had along the lines suggested above would be most interesting.

Yours faithfully,

B. A. PEGG,

Lenkurt Electric Co. Inc.,
California, U.S.A.

The author replies:

DEAR SIR,—Thank you for your interesting comments on the use of the above equipment.

The desirability of monitoring the actual transmitted intelligence while making a frequency measurement was recognized, and the existing design does

in fact allow for this. The c.r.t. deflexion amplifiers are sharply tuned at 100kc/s, and thus the overall selectivity characteristic to the visual indicator is considerably narrower than that to the receiver demodulator, when the wider i.f. bandwidths are employed. This extra selectivity tends to discriminate against modulation components and other unwanted signals, which might be present in the receiver pass-band, and offers similar advantages to the twin channel i.f. you propose.

The accurate measurement of transmissions using reduced or suppressed carrier, demands rather more skill on the part of the operator. Provision is made in the RA:17 receiver for the calibration and setting of the b.f.o. against the 100kc/s standard reference signal, the b.f.o. may then be used to demodulate the incoming transmission and the frequency can be measured with only slight degradation of accuracy. Experience with the equipment has shown that it is possible to measure the individual component frequencies of complex f.s.k. transmissions without difficulty, but in this case it is desirable to use the 100c/s receiver pass-band in conjunction with the visual indicator. A good indication of the frequency of narrow-band frequency modulated transmissions can be obtained using the method you suggest, of tuning the receiver for maximum detector current using one of the narrower i.f. pass-bands.

It is of course perfectly possible to set the receiver precisely to any desired frequency, merely by setting the tuning controls to give the correct indication on the counter.

Yours faithfully,

G. F. MEAKES,

Racal Engineering Ltd, Bracknell.

A Selective *RC* Amplifier Using Transistors

DEAR SIR,—In his article entitled 'Selective *RC* Amplifier using Transistors', February 1961, R. Hutchins has shown that a modified dual of a Wien bridge arm can be used in a transistor selective amplifier. It may be of interest to note that the modified dual network may be derived also, by interchanging two parameters in the *A* matrix of the Wien bridge arm provided certain approximations are made.

In Fig. 1 let the input and output voltages and currents of a selective network in either a valve or transistor selective amplifier be related by the expressions:

$$V_1 = AV_2 + BI_2$$
$$I_1 = CV_2 + DI_2$$

or

$$\begin{Bmatrix} V_1 \\ I_1 \end{Bmatrix} = \begin{Bmatrix} A & B \\ C & D \end{Bmatrix} \cdot \begin{Bmatrix} V_2 \\ I_2 \end{Bmatrix}$$

When the output terminals are connected to the input of a valve amplifier stage it may be assumed, at low frequencies, that I_2 is negligibly small so

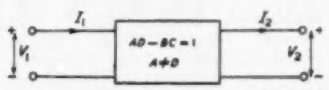


Fig. 1. The selective amplifier

that $V_1 = AV_2$. Had the output terminals been connected to the input of a transistor amplifier stage instead, V_2 could have been assumed negligibly small so that $I_1 = DI_2$.

In order that the selective properties

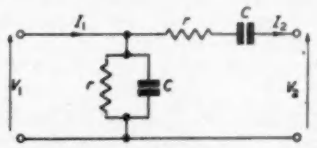


Fig. 2. Realization of network

of a Wien bridge arm can be applied to a transistor amplifier the *D* term of the transistor amplifier network must be the same as the *A* term of the Wien bridge arm. The input and output voltages and currents for the transistor amplifier network are then related by:

$$\begin{Bmatrix} V_1 \\ I_1 \end{Bmatrix} = \begin{Bmatrix} D & B \\ C & A \end{Bmatrix} \cdot \begin{Bmatrix} V_2 \\ I_2 \end{Bmatrix}$$

This network is realized simply by turning the Wien bridge arm round as shown in Fig. 2 to give the same circuit as the modified dual described in the article.

Yours faithfully,

M. F. MCKENNA,

Automatic Telephone & Electric Co. Ltd,

School of Electronics, Liverpool.

Measurement of Transistor Switching Parameters

DEAR SIR,—May I comment on Mr. Ercoli's letter on the Measurement of Transistor Switching Parameters which appeared in your issue of October 1960.

In principle it is of course true that if the driving voltage step V' to the input capacitor C in his Fig. 1 is very rapid, if the generator resistance and base resistance are small and if the oscilloscope used to observe the waveform has sufficient bandwidth and has negligible input capacitance, then when the positive going transient on the collector reaches a level on the oscilloscope face corresponding to the edge of saturation then $V'C = Q_{cn}$. If, however, any of these conditions are not met then the rise-time of the collector voltage will be degraded, and since the base charge begins to disappear by recombination as soon as any is present in the base, the height of the observed voltage transient will fall, and anyone carrying out these measurements will increase V further than the true value to bring the transient to the proper level.

Some simple calculations will illustrate the point. If T_{co} is 0·02μsec (as for an r.f. alloy transistor), if its current gain is 50 and if it is being tested for a 10mA on-value of I_c, then the collector current will drop as a result of recombination in the base at 10mA/μsec at the instant that I_c = 10mA. Consequently if as a result of oscilloscope bandwidth, driving circuit time-constant and capacitive loading on the collector the rise-time is limited on the oscilloscope screen to 0·1μsec, then an error of the order of 10 per cent in the setting of V_c is inevitable; that is it will be necessary to put in base charge sufficient for I_c = 11mA if one is to 'see' a 10mA collector current swing. The presence of Q_v, and any decrease in T_{co} or current gain will increase these errors. Indeed times much less than 10mμsec must be observed if errors are to be avoided with diffused base transistors.

If the transistor exhibits the 'wiggle' effect, correct settings are impossible, for one is not interested in the charge to turn on 10mA 'instantaneously' but rather that charge which will turn on 10mA without a subsequent decrease, and it is not possible to find such a setting with this technique.

All the above comments apply equally if any triggered device is used for detection in place of an oscilloscope. The crucial transient at the top of the waveform is easily lost as in Mr. Ercoli's Fig. 2(a).

If on the other hand, as in the circuits I have described[1], base current is also supplied to the transistor by connecting a resistor in parallel with C of value such that $I_b = I_c$/(current gain), then no fall of I_c results from recombination, and the measurements are substantially independent (within reason) of rise-times and bandwidths associated with test equipment and the transistor. Any error results from uncertainty in the adjustments, not from inherent error.

Finally, I should point out, as I have done recently elsewhere[2], a technique which involves varying R_c in order to separate the terms of Mr. Ercoli's equation (1) is also subject to inevitable error owing to the variation of T_{co} with I_c.

Yours faithfully,

J. J. SPARKES,

British Telecommunication Research Ltd,

Taplow, Berkshire.

REFERENCES

1. SPARKES, J. J. The Measurement of Transistor Transient Switching Parameter. *Proc. Instn. Elect. Engrs* 106*B*, 562 (1959).
2. SPARKES, J. J. A Study of the Charge Control Parameters of Transistors. *Proc. Inst. Radio Engrs.* 48, 1696 (1960).

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THE ELECTRONIC COMPONENT EXHIBITION

A description, compiled from information supplied by the manufacturers, of a selection of the exhibits at the Exhibition of the Radio and Electronic Components Manufacturers Federation at Olympia, London, from 30 May to 2 June.

(Voir page 399 pour la traduction en français ; Deutsche Übersetzung Seite 406)

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These devices can provide storage of digital and analogue data. The devices have the unique feature of providing intrinsic non-destructive read-out of stored data through the correct geometric and magnetic arrangement of minor apertures around a major aperture.

The principles of operation are briefly as follows. Flux switching begins at the inner diameter (or shortest magnetic path) of a toroidal core and proceeds outward to the outer diameter (longer magnetic path) until the flux field is entirely reversed. For a given material, the switching threshold can be lowered by decreasing the inner diameter of the core and raised by increasing the inner diameter. Saturation drive can be affected by applying the same rule to the outer diameter. Through precise control of ferrite material, a linear relationship between drive and remanent flux can be achieved and the minor aperture threshold is significantly less than the major aperture since its path length is less.

Unlike conventional toroidal cores, a MAD core is 'set' by reversing half of the total remanent flux. By applying full 'set' drive to a core previously cleared, remanent flux is reversed on the major aperture to a point half-way between the inner and outer diameters of the core. Now, remanent flux exists in a counter-clockwise direction on the inner leg and clockwise on the outer leg of the core. The intrinsic non-destructive output of a MAD core is a characteristic of its minor apertures in the 'set' condition.

If a minor aperture is threaded with a primary (drive) and secondary (output) winding, continuous non-destructive read-out can be obtained on the output winding, transformer coupled to its primary winding by the outer leg of the minor aperture. In the 'set' condition, the drive applied to the minor aperture primary winding switches flux locally around the minor aperture and is adjusted to a value less than the major aperture threshold level. In the 'clear' condition and with controlled minor aperture drive, remanent flux cannot be switched around the minor aperture and thus no output can occur. Flux switched around a minor aperture does not destroy the 'set' condition of the core.

EE 34 751 *for further details*

ANTIFERENCE LTD

Bicester Road, Aylesbury, Buckinghamshire

LOFT AERIAL

This new loft aerial, type HL514, is available in all Band I/III channel combinations for vertical polarization. It has a double-driven array incorporating a telescopic single dipole for Band I and for Band III elements. The aerial is complete with angled arm and bracket.

EE 34 752 *for further details*

BALANCER

This new unit is a 'frequency conscious attenuator' and is designed for easy insertion into television aerial down-leads to provide variable attenuation of Band I signals without affecting Band III, or of Band III signals without affecting Band I; so enabling a balanced signal to be easily obtained in areas where non-co-siting of transmitters, different power or reception conditions result in an unequal signal being received.

EE 34 753 *for further details*

ASHBURTON RESISTANCE CO. LTD

72 Brewery Road, London, N.7

PRINTED CIRCUIT RESISTORS

These precision resistors have been designed specifically for use on printed circuits. Known as the ERP 1, this resistor has been developed to help overcome the problem of fractured termination leads often encountered when resistors are mounted on printed circuit boards. Design features include stout 21-gauge tinned copper radial end leads.

The ERP 1 has a tenth-watt rating and is intended for use on 0·1in module grids, having a distance between termination centres of 0·4in. Tolerances of red, green, yellow and blue (±1, 0·5 0·25 and 0·1 per cent respectively) are available.

This system of colour coding, recently introduced by Ashburton for quick and accurate identification of tolerances. is used on all Arcol precision resistors.

Initially, epoxy resin encapsulation is being used for the ERP 1.

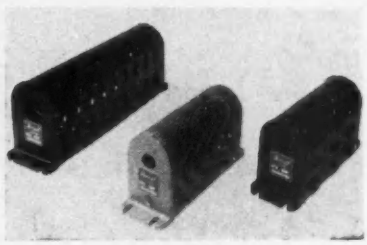
EE 34 754 *for further details*

HEAVY DUTY RESISTORS

(Illustrated above right)

200 to 750W resistors have been introduced into the Ashburton heavy duty range. The covers of these resistors are of louvred or perforated sheet steel and a variety of finishes are available.

The covers mask the live parts of the resistors so that they can be mounted with safety outside a unit but the terminal blocks remain easily accessible.



Two types of louvred cover are available—one with vertical and the other with horizontal louvres. Thus a heavy duty resistor can be mounted either vertically or horizontally within a unit and the winding will always be protected from condensation drips.

EE 34 755 *for further details*

BADER MACHINERY CO. LTD

Hersham Factory Estate, Walton-on-Thames, Surrey

A wide range of high-speed automatic equipment for the manufacture of semi-conductors, incandescent lamps, radio valves and cathode-ray tubes is produced by this company. Typical of the machines available are the following.

16-HEAD DIODE DUPLEX BEADING MACHINES

The machine is fitted with a totally enclosed gearbox with hardened and ground tapered steel rollers engaging in a three dimensional barrel type indexing cam, which is cut to ensure constant acceleration and deceleration. The seal heads rotate in the fire positions and are controlled by a separate variable speed drive. All the major bearings of the machine are automatically lubricated from a central position, and all the feeding hoppers and other parts in contact with the components are highly polished and Perspex covers are provided to protect any components in the hoppers from the ingress of dust, etc. Maximum indexing speed 2 000 per hour: i.e. maximum output equals 4 000 sub-assemblies per hour. The sequence of operation is as follows:

(a) Automatic feeding of the electrodes either from a reel or from a hopper using pre-cut electrodes. When the electrodes are reel fed, a straightening device and cutting unit is fitted to ensure accurate components.

(b) Automatic loading of pre-cut glass beads from a hopper.

EE 34 124 *for further details*

NEW

300 μV to 3 V up to 900 Mc/s and D.C.

MILLIVOLTMETER TYPE 301

The Airmec Millivoltmeter Type 301 is a compact, lightweight instrument employing advanced circuitry to achieve a low noise level and a high degree of stability. It measures alternating voltages from 300 microvolts to 3 volts in the frequency range 100 c/s to 900 Mc/s, and direct voltages from 100 microvolts to 10 volts. A.C. inputs are rectified in a probe containing semiconductor diodes; for low frequency measurements the probe is plugged into a holder on the front panel, and alternative positions on the holder provide input impedances of 75 or 52 ohms. The advantage of this arrangement is that the attenuator handles only D.C., and is therefore free from frequency errors. The probe lead retracts into the case when not in use, stowage is provided at the back of the instrument for prods and mains cable, and the fuses and mains voltage adjustment are accessible without dismantling

FREQUENCY RANGE:
100 c/s to 900 Mc/s and D.C.

AC RANGE:
300 μV to 3 V in 8 ranges (also calibrated in dB relative to 1 volt)

DC RANGE:
100 μV to 10 V in 10 ranges

ACCURACY:
AC 5% fsd 1 mV to 3 V up to 200 Mc/s
DC 5% fsd 300 μV to 10 V

INPUT IMPEDANCE:
AC 120 kohms + 2pF at 100 kc/s; alternatives of 75 ohms and 52 ohms available at plug-in unit on front panel.
DC 5 Mohms

Airmec

AIRMEC LIMITED, HIGH WYCOMBE, BUCKS Tel: High Wycombe 2501

Now approved for the British Army

THE HF156 manpack transmitter/receiver is a thoroughly reliable, robust, fully sealed and entirely self-contained portable set for active service in extreme climatic conditions. Six crystal-controlled channels, extreme simplicity of operation and exceptional range on voice and CW are some of the many features that stood out during extensive user trials in the Far East. The military-type one-man canvas pack in the picture above contains the combined transmitter/receiver and power supply and the aerial loading unit. A pocket contains handset, morse key and headset with boom microphone when they are not in use. A sectional rod aerial and its flexible base are also carried. Dipole and end-fed aerials, in a separate haversack, need be carried only when required. Provision is also made for vehicle-borne operation and for the use of non-spillable lead/acid accumulators or dry batteries, greatly increasing the versatility of this latest set in the BCC HF15 series.

Ask for a leaflet describing the HF156 and the additional facilities for vehicle-borne operation and for power supply from lead/acid accumulators or dry batteries.

*

BCC also design, engineer, instal and service complete communications systems. Our advisory service would be glad to have the opportunity of helping you.

BCC

*

BRITISH COMMUNICATIONS CORPORATION LIMITED

HIGH WYCOMBE BUCKS — TEL : HIGH WYCOMBE 2501

Grams : BeeCeeCee High Wycombe — And at Wembley

(c) The bead is sealed to the electrode by gas burners and during the sealing process the heads rotate at a fast speed to produce a concentric seal.

(d) The complete component is automatically unloaded into magazines containing 50 positions. The magazines being hand-loaded and then automatically indexed through the unloading point.

(e) Should there be no components in the heads, the magazines will not index, thus ensuring that all magazines leaving the machine are full.

(f) A head cleaning position is fitted after the unloading position which allows a jet of high pressure air to clean out the head before any new components are loaded.

(g) The magazine runways are designed to accommodate three magazines, with a full magazine being delivered to the unloading point approximately every 1½ minutes.

EE 34 756 *for further details*

DIODE ALLOYING OVEN

A horizontal tunnel type and vertical oven are standard, each having specific advantages.

In the alloying oven, magazines filled with loaded body sub-assemblies are moved into two electrically heated zones, a pre-heating and a high temperature one (variable between 200°C and 800°C). Inert gas inlets are fitted so that inert gas can be fed into the oven to provide a protective atmosphere. During the soldering process the solder pellet is melted and the weight presses the dice to make a good junction with the electrode. Automatic temperature control is fitted to maintain a temperature inside the oven within 5 per cent of the dial setting.

After alloying, the magazines are transferred to a cooling zone, where the temperature of the magazine is brought down to approximately 20°C. This is the buffer station to allow for the length of time required to cool the magazines. After cooling, the operator removes the magazines ready for the next operation. As the operator removes the magazines he allows the weights to fall out, so that they can be returned for further use.

EE 34 757 *for further details*

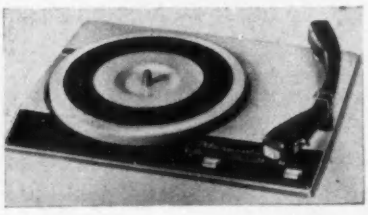
BIRMINGHAM SOUND REPRODUCERS LTD

Monarch Works, Old Hill, Staffordshire

GRAMOPHONE UNIT

(Illustrated below)

The GU6 is a compact gramophone unit providing speeds of 16, 33⅓, 45 and 78 rev/min. It has an automatic stop at the end of each record and automatic throw-out of the rubber jockey pulley wheel when the unit is switched off. The unit is spring mounted to reduce cabinet resonance and it is claimed that wow, flutter and rumble are virtually non-existent. The pick-up will take any of the B.S.R. 'Ful-Fi' range of cartridges.



EE 34 758 *for further details*

DAWE INSTRUMENTS LTD

99-101 Uxbridge Road, Ealing, London, W.5

TRANSISTORIZED PHASEMETER

(Illustrated below)

The type 630 phasemeter is an all transistor mains or battery powered instrument which measures phase difference between two signal sources. Two limiting amplifiers are fed respectively by the signal and reference inputs. The resulting outputs are differentiated and positive pulses derived with the same phase relationship as the input signals. The pulses from one amplifier switch a bistable circuit 'on', those from the other switch it 'off'. The mark-to-space ratio of the rectangular waveform derived is directly proportional to the phase difference between the input sources, and this is expressed directly on a moving-coil meter.

The frequency range is 1c/s to 25kc/s and the phase-angle ranges are 0° to 360° and 180°-0-180°. The accuracy with balanced signals is ±3°.

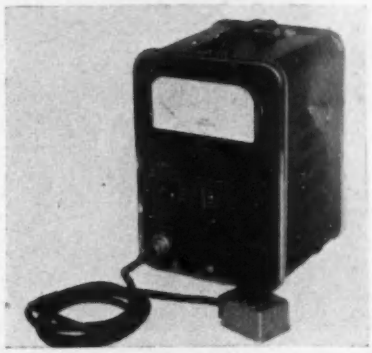
EE 34 759 *for further details*

TRANSISTORIZED VIBRATION METER

(Illustrated above right)

The transistor vibration meter type 1431 comprises a vibration pick-up, a high gain amplifier incorporating integrating and differentiating networks and an adjustable attenuator, together with a direct reading indicating meter. The portable transistor instrument is designed to measure the three important characteristics of vibration, displacement, velocity and acceleration. The instrument is invaluable at all stages of research, design and production, where the detrimental effects of wear and noisy operation must be avoided.

The type 1403/1 vibration pick-up supplied with the instrument is of the moving-coil type and gives an output proportional to the velocity of the motion under investigation. The instrument will operate from a self-contained battery power supply and can also be used with standard mains power supplies.



Vibration Ranges: Displacement: Seven ranges 0 to 0·0003in to 0 to 0·3in zero to peak.

Velocity: Nine ranges 0 to 0·003in/sec to 0 to 30in/sec peak.

Acceleration: Five ranges 0 to 100in/sec² to 0 to 10000in/sec² peak.

Frequency Range: 5c/s to 2000c/s.

A Type 1431B calibrated in metric units is also available.

EE 34 760 *for further details*

ELECTRONIC COMPONENTS LTD

Weedon Road, Industrial Estate, Northampton

FOUR CHANNEL MIXER

(Illustrated on page 392)

This instrument has been designed to fill the need for a compact multi-channel mixer, with a performance adequate for professional needs and at the same time within a price range to appeal to the amateur.

The circuit of the instrument has been evolved from the Elcom electronic fader and combined in such a form so as to retain simplicity with good performance.

Facilities available are four separate inputs at high impedance into pre-amplifiers with a gain of 20dB and incorporating preset gain, bass and treble boost and cut. Each channel is controlled by a quadrant type of fader, allowing the channel to be faded in or out separately, within the range 0 to 60dB and off. Extending from the off position each channel fader has a pre-listen position allowing the controller to listen on a selected channel when this channel is out of circuit with the mix. The controller may then quickly and easily fade the channel 'in' when he hears the appropriate cue point. This feature is linked to the aural monitor outlet detailed below.

The four channels are combined in a mixer unit and controlled by a quadrant type of master fader, again over the range 0 to 60dB and off. The final mixed and controlled output is available normally at an impedance of 600Ω, higher output impedances can be made available to order.

Visual peak level monitoring is provided, as is also an outlet, from the final mixed signal, at 5kΩ, to a jack socket, for aural appreciation and pre-listen.

The channel and master faders are fitted with coloured cue lights showing green for channel 'off', and red for channel 'in'.

The mixer has a total harmonic distortion figure better than 0·25 per cent. Signal-to-noise ratio is better than 70dB and frequency response is adequate from 40c/s to well above audibility.

An important feature of design is the use of plug-in units for the individual parts of the circuit and fader units, thus in the event of a fault occurring isolation can be quickly established and a spare unit plugged in.

An external supply at 12V d.c. is required for both the electronic circuit and signal lamps, the two circuits being separately brought out to a plug, so as to allow the use of a low capacity supply for running the electronic requirements only during portable or field use.

EE 34 761 *for further details*

GARDNERS RADIO LTD

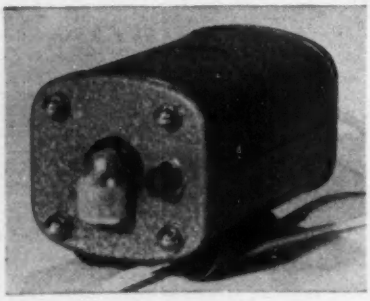
Somerford, Christchurch, Hampshire

ISOLATING TRANSFORMERS

(Illustrated below)

To meet the varied requirements of domestic appliances, small machinery and low voltage lighting, etc., Gardners are producing a new range of portable auto-wound, isolating and low voltage transformers called the Castle Series.

To simplify the design, windings are for a standard input of 230-240V but transformers for other supply voltages are supplied to special order. The double wound types CAS.900 to CAS.916 are centre-tapped to comply with safety regulations and are provided with an electrostatic screen between windings. All the transformers are rated for continuous running, and in cases where they are required for intermittent use, for example, short periods of running with equal periods of rest, the next lower rating may usually be selected. Each transformer is supplied with five feet of flex for the input connexion and a suitable plug for the output supply. The input is fused with an easily replaceable screw type fuse.



The double wound versions of these transformers are available with output ratings from 12V, 12VA to 110V, 500VA and 240V, 200VA. The auto-wound versions provide an output of 115V at from 25VA to 550VA.

EE 34 762 *for further details*

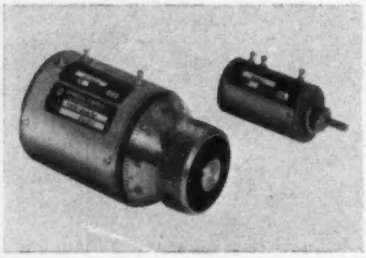
GENERAL CONTROLS LTD

13-15 Bowlers Croft, Honeywood Road, Basildon, Essex

HELICAL POTENTIOMETERS

(Illustrated below)

The PK15 and PM15 series of helical potentiometers are precision miniature three and ten-turn helical instruments.



The outstanding feature is the precision nature of such a small helical with a maximum value on the ten-turn of 120kΩ and on the three-turn 40kΩ.

It has positive end stops and can be supplied with ball or sleeve bearings, bush or servo mountings. Best practical linearity on special orders is ±1 per cent. The body diameter is ¼in and overall length 1·483in on the ten-turn model.

The PK30 and PM30 series are precision three and ten-turn helical potentiometers with a maximum value on the three-turn of 150kΩ and on the ten-turn of 500kΩ. The units have positive end stops and can be fitted with ball or sleeve bearings. They can be supplied for bush or servo mountings. Body diameter is 1 13/16in and on the ten-turn the overall length is 2in. Overall length on the three-turn is 1·228in. Best practical linearity on selected value 0·05 per cent.

EE 34 763 *for further details*

TURNS COUNTER

(Illustrated above right)

The CM-3 turns counters are an aid in positioning or reading precision rotating, components, such as multi-turn potentiometers and variable capacitors. Large, clear digital dials provide direct reading at a glance indicating the exact position of the multi-turn device.

Constant torque provides sensitive feel for allowing extremely precise adjustments. Smooth rotation of all moving parts with minimum of backlash ensures true and accurate reading for every slight change or movement of the main shaft.

The counters are available in three digit dial models which are easily adapted to rotating devices with up to a maximum of ten turns (3 600°). Readings indicate percentage of total rotation, full turns, tenths and hundredths.

Later, six models will be produced for ¼in and ¼in spindles.

EE 34 764 *for further details*

SERVO POTENTIOMETER

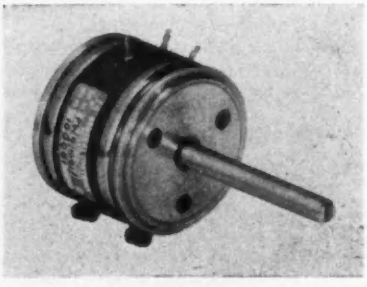
(Illustrated below)

All parts of this precision potentiometer of American design are precision machines with ball races fitted in the lid and base to ensure minimum end and side play on spindle and low operating torque.

The effective angle of resistance on standard models is 300°, but this can be increased to 355° for special orders. The maximum value is 200kΩ on a card winding. Independent linearity can be held to 0·25 per cent on selection.

Measuring 1 13/16in in diameter with a depth of 1 7/32in and with a 4W rating on a card winding, and a 2W rating on a Lewmex former winding, the unit can also be produced as a slide wire with infinite linearity up to 10Ω. Ends of winding are tap welded on to turret lugs for accuracy and stability.

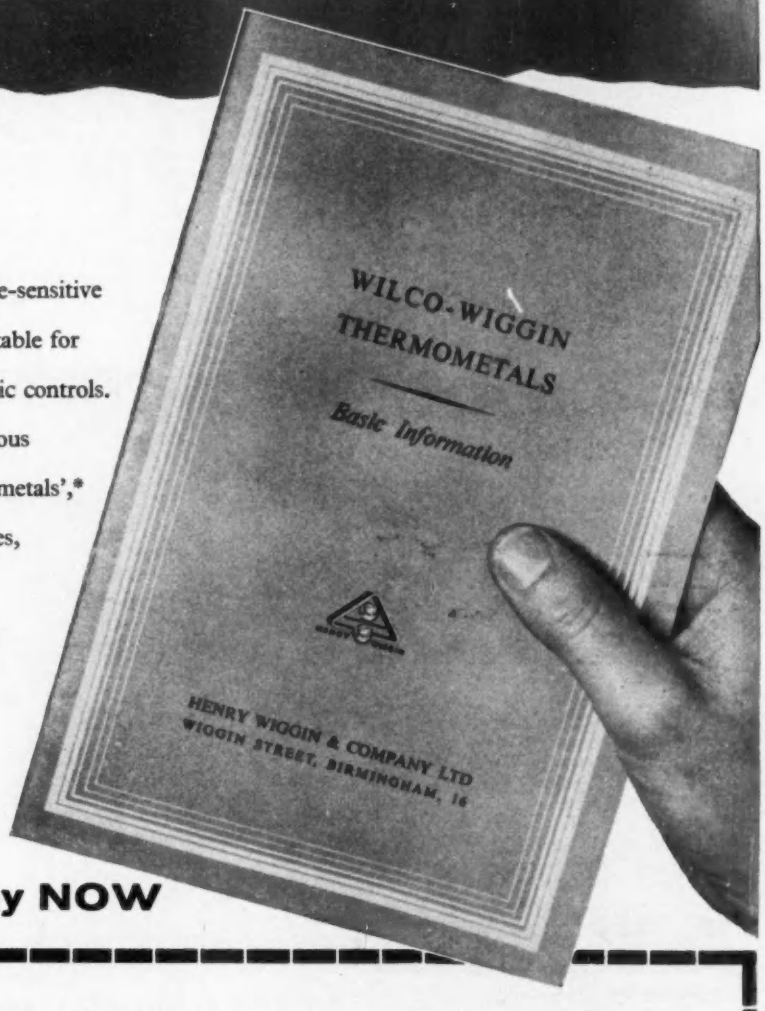
Silver-plated turret lugs are fitted with 282 alloy precious metal wiping contact and the potentiometer can be ganged up to six units.



EE 34 765 *for further details*

WILCO-WIGGIN

Thermometals



THERMOMETALS are temperature-sensitive bimetals produced in several grades suitable for use in a wide variety of thermostatic controls. This new publication describes the various grades of 'Wilco-Wiggin Thermometals',* with tables of thermal properties, design formulæ for various types of mechanism, and details of fabrication and heat-treatment.

*TRADE MARK

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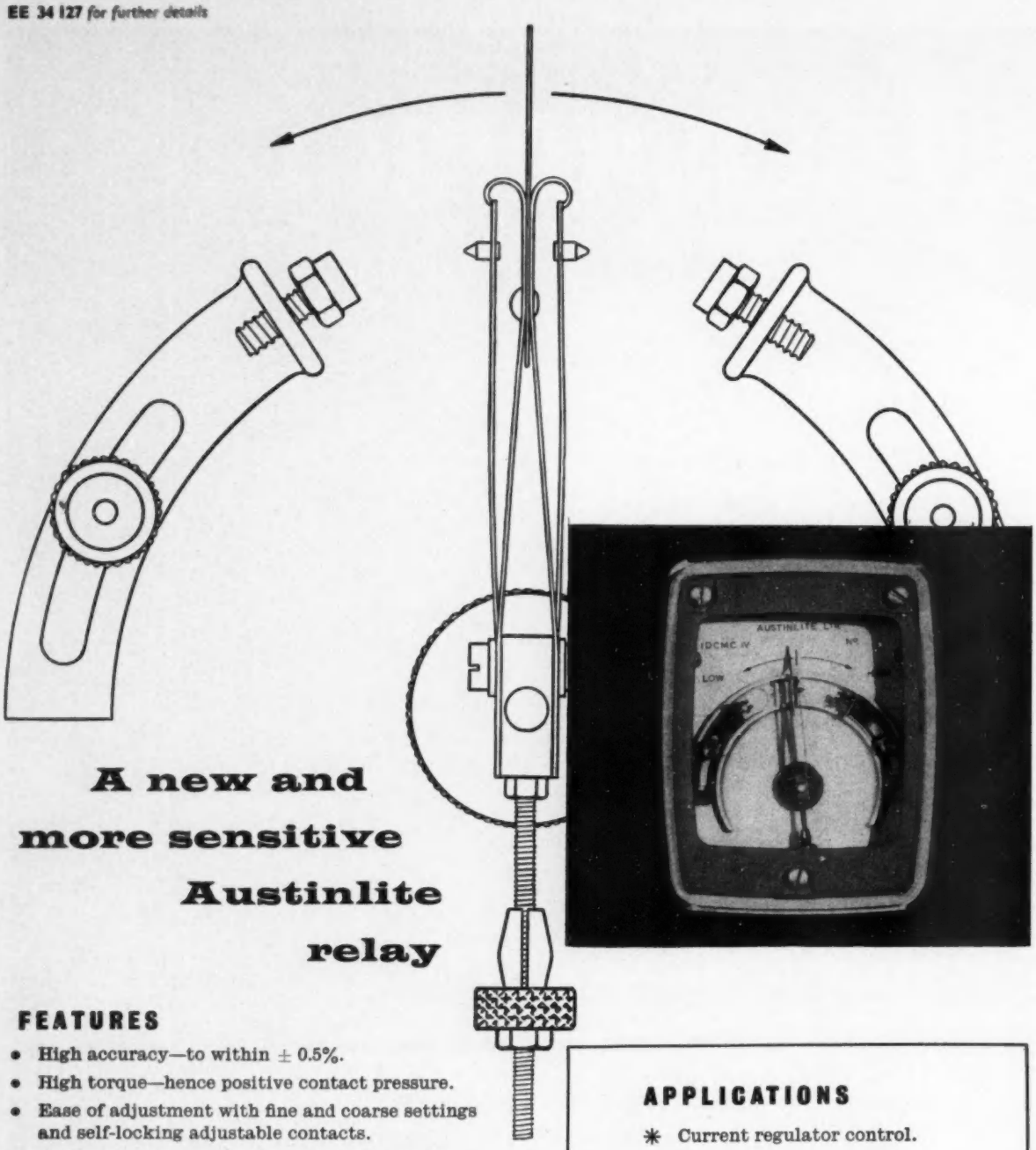
TGA M31

EE 34 127 *for further details*



A new and more sensitive Austinlite relay

FEATURES

- High accuracy—to within ± 0.5%.
- High torque—hence positive contact pressure.
- Ease of adjustment with fine and coarse settings and self-locking adjustable contacts.
- Choice of either two or four adjustable contacts.
- Contemporary case design—projection or flush mounting.
- Dustproof and suitable for use in the tropics.
- Conforms to Post Office Specification P.T. 1025B.
- Suitable for current or voltage sensing on either D.C. or A.C.

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- ✳ Current regulator control.
- ✳ Voltage regulator control.
- ✳ Monitoring duties.
- ✳ Limiting duties.
- ✳ Equipment protection.

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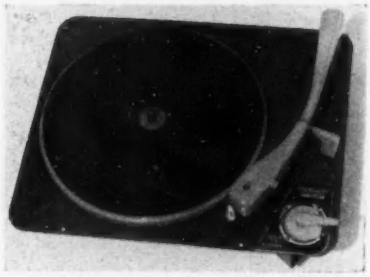


THE GOLDRING MANUFACTURING CO. (Great Britain) LTD

486-488 High Road, Leytonstone, London, E.11

BATTERY OPERATED TURNTABLE

(Illustrated above)

This battery operated four-speed gramophone turntable unit is provided with an automatic stop mechanism and is powered by a six pole d.c. motor with very low current consumption. Constant speed is maintained over a voltage range of 5 to 9V. The 8in turntable is semi-recessed and the overall dimensions are 9in by 11in. The unit is supplied complete with a pick-up arm and cartridge.

EE 34 766 *for further details*

HELLERMANN LTD

Crawley, Sussex

CABLE MARKING AND BINDING SLEEVES

Three new types of cable sleeves have been developed. These are as follows:

Helsyn 150

This new sleeve has been developed because of increasingly high performance requirements. Helsyn 150 is to replace Helsyn 100 as it has a much increased fluid, ozone and heat resistance factor.

Helsyn TX

Helsyn TX sleeves and markers will replace the present grade of Helsyn because of its very high ozone resistance qualities and is extruded from a neoprene based compound, have no rubber content and meet fully the conditions of specification DEF20.

Twintex

Twintex is a new type of Hellermann sleeve, developed with high temperature and fluid resistant qualities superior to those of Helaprene sleeves.

EE 34 767 *for further details*

THE LEWIS SPRING CO. LTD

Resilient Works, Redditch, Worcestershire

TRANSISTOR CLIPS

Manufactured from beryllium copper and so formed as to assist in heat dissipation, the L.S. transistor clip range is designed to suit cylindrical transistors such as the Mullard OC72, SB345 and OC170 types, and can be quickly and easily fixed horizontally to printed circuit boards through 5/32in diameter holes.

EE 34 768 *for further details*

MARCONI INSTRUMENTS LTD

St. Albans, Hertfordshire

WIDE-RANGE RC OSCILLATOR

(Illustrated below)

This wide-range Wien-bridge oscillator covers 10c/s to 10Mc/s (sine wave) in six decade bands. The top band, with its exceptionally wide cover of 1 to 10Mc/s and stable output characteristics, is suitable for response testing in the video and lower h.f. bands. A single scale is used for the four lower bands and separate scales for the two upper bands; this gives a total scale length of 105in and makes a 1 per cent change in frequency easily discernible. Speed and precision of tuning are reconciled by a dual-ratio control, 3:1 for rapid adjustment and 18:1 for fine tuning.

Outputs from 1mV to 3·16V are available via a switched attenuator covering 60dB in 10dB steps. The signal level applied to the input of the attenuator is continuously variable and is monitored

by a meter calibrated in open circuit voltage and decibels. The output impedance can be set to 75, 100 or 600Ω. Low outputs down to 10μV at 75 or 5Ω can be obtained by means of a ×100 attenuator pad available as an optional accessory. High outputs up to 31·6V, at frequencies below 100kc/s, are delivered at a separate outlet.

The instrument is very suitable for use with transmission lines, filters, attenuators, etc. Among other applications as a sine wave generator is that of providing the excitation voltage for a.f. and r.f. bridges.

The TF 1370 also delivers a high quality square wave output up to 31·6V peak, at frequencies between 10c/s and 100kc/s.

EE 34 769 *for further details*

WIDE-BAND MILLIVOLTMETER

(Illustrated above right)

Wide frequency cover (30c/s to 30Mc/s) combined with stability, accuracy and sensitivity, make this a voltmeter of broad applicability. The voltage range is 100μV to 300mV or up to 30V with optional multiplier.

The TF 1371 will measure small a.c. voltages from power-supply frequencies to the threshold of v.h.f.; it can be used on r.f., i.f., video and audio amplifiers; and it allows measurement of signal

levels throughout h.f. receivers, from aerial to loudspeaker.

Its 5½in meter responds to the average value of an a.c. waveform and is calibrated in the r.m.s. value of a sine wave; it has two millivolt scales, and a scale showing decibels relative to 1mW in 600Ω. To maintain long-term accuracy, the calibration can be easily standardized against an internal source.

EE 34 770 *for further details*

PRECISION CRYSTAL CALIBRATOR

(Illustrated below)

The TF 1374, which covers the frequency range 100kc/s to 1 500Mc/s with a stability of 1 part in 10^8 per month, provides precision crystal check points in the form of headphone zero-beats. The points occur at switch-selected intervals of 10Mc/s, 2Mc/s, 500kc/s, or 10kc/s. Each series of points is available separately, and completely free from subharmonic beats. The 100kc/s points are clear and distinct up to at least 500Mc/s and the 10kc/s points are usable up to 10Mc/s. Outputs at each of the check frequencies are available.

Accuracy, simplicity of operation, and clearly indentifiable check points without spurious intermediate beats, make the instrument ideal for such purposes as standardizing signal generators and oscillators or setting up h.f., v.h.f. and u.h.f. transmitter frequencies. Its standard-frequency outputs may be used for calibrating receivers or wavemeters; the useful frequency range for receiver testing depends on the sensitivity, second-channel and i.f. breakthrough, but with average receivers it can be used up to at least 100Mc/s.

In an alternative version, type TF 1374/1, the 10kc/s series of crystal check points is replaced by 25kc/s points which are usable up to about 200Mc/s.

EE 34 771 *for further details*

MICROCELL ELECTRONICS LTD

Blackwater, Camberley, Surrey

TRANSISTOR POWER SUPPLY

The type 410 is a bench-type supply providing a continuously variable output voltage from 1 to 30V with an output current of 5A. Voltage levels are adjusted by a variable ratio transformer producing high reliability and repeatability. Output voltage and current are monitored on a built-in meter and a rapid-acting cut-out protects the supply and the external circuit should over-loading occur. Rating is continuous to 35°C.

The unit is built on a 19in front panel. It is normally housed in a Microcell case, but is suitable for rack mounting.

The output resistance is less than 0·01Ω and the a.c. impedance less than 0·3Ω up to 100kc/s. The stability ratio is 500:1 for 7·5 per cent variation of mains input.

EE 34 772 *for further details*

STABILIZED E.H.T. SUPPLY

The type 411 is a heavy duty e.h.t. supply with a continuously variable output from 500V to 3kV at 10mA.

Built on a 19in front panel the supply is suitable for rack-mounting, but is normally supplied in the new Microcell case.

Special attention has been paid to safety precautions in the unit which is extremely safe to use.

The ripple is approximately 17mV peak-to-peak fully loaded and the stabilization ratio 2000:1 at 2kV 5mA. The output impedance is approximately 100Ω.

EE 34 773 *for further details*

THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

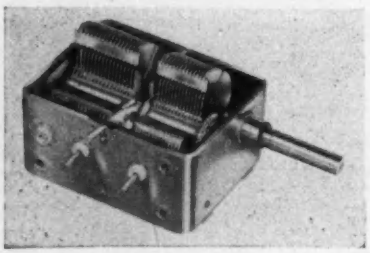
GANGED CAPACITOR

(Illustrated below)

The two gang capacitor, type 28, is intended for those radio receivers demanding a high performance tuning unit.

The rigid style of frame ensures freedom from low-frequency microphony and the rigid rotor assembly and widely spaced vanes in the oscillator section give freedom from vane microphony. The capacitance swings are ample for all wave ranges and are very suitable for the full short-wave band without padding correction. A very high order of capacitance matching accuracy between the two sections enables the receiver designer to provide tuned circuits with a negligible loss due to any mismatching between r.f. and oscillator sections.

An internal gear drive can be fitted, standard ratios being 3 to 1, 6 to 1 and 8 to 1.

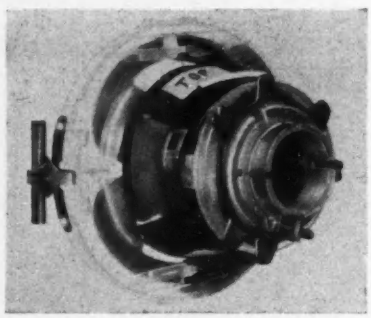


EE 34 774 *for further details*

110° SCANNING COILS

(Illustrated below)

This series of scanning coils is intended for 17 to 23in 110° television tubes. The coils are wound on a polypropylene moulding and can be used at all temperatures likely to be encountered in television receiver service.



Special form jigs are used in winding the coils to ensure undistorted raster shape and good focus overall. Minimum coupling between line and frame coils means that full advantage can be taken of modern trends in simplified frame time-base circuits.

The coils are available with high or low impedance windings and there is a choice of fixed or adjustable magnets for picture control.

A new centring unit has been developed which uses a ferrite loaded plastic to eliminate the power loss present in conventional centring devices. Another advantage of this plastic control magnet is that it retains its magnetism permanently and does not become demagnetized by the scan coil field.

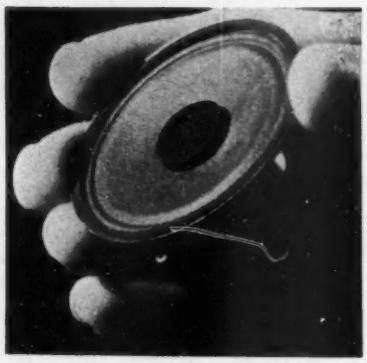
EE 34 775 *for further details*

MINIATURE LOUDSPEAKER

(Illustrated above right)

This 2½in diameter loudspeaker is intended for use in modern miniature transistorized radio receivers.

The magnetic circuit uses a new constructional technique to enable the overall depth to be reduced to a minimum—a rod magnet being inserted into a split aluminium ring which is fitted into an accurately machined yoke. This design arrangement gives a compact, robust motor unit without the use of magnet assembly bolts.



The 2½in diameter loudspeaker is available with a low impedance voice coil (8 to 10Ω) for use with a matching transformer or alternatively with high impedance coils for direct connexion into transistor circuits.

EE 34 776 *for further details*

STABILITY CAPACITORS LTD

Commerce Estate, Raven Road, London, E.18

POLYESTER CAPACITORS

(Illustrated below)

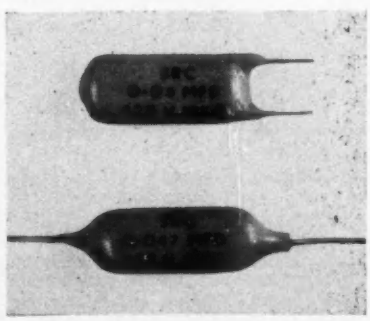
These capacitors have been introduced following the trend to miniature components and are suitable for transistor radio receivers as well as for general application.

The capacitance range available is from 0·01μF to 0·1μF at 125V d.c. working.

The demand for this range of capacitance values has previously been met by either paper and foil or metallized paper capacitors. The polyester capacitor offers many advantages compared with both these types, being smaller than the paper and foil and more economical than the metallized paper. In addition, polyester foil is insensitive to moisture and is stable up to high temperatures. The method of construction gives a very low self-inductance.

Combining these properties with the protection offered by a hard cement coating results in a low cost capacitor which fulfils most requirements.

Polyester capacitors are available with axial leads or a novel and compact design with plug-in tags (patent applied for) for printed circuits.



EE 34 777 *for further details*

SEL introduce a new UV Recorder

with outstanding features:

- **Direct writing with fast presentation**
- **High sensitivity – 1.8μA/cm at 100 c/s**
- **High frequency response – up to 5 kc/s**
- **Up to 50 recording channels**
- **Paper speed range from 1.25 to 2,000 mm/sec, with push-button operation**
- **Trace intensity control**
- **Remote control facility**
- **Shot control – exposes pre-determined lengths of recording paper**
- **Trace identification**

GENERAL SPECIFICATION

This recorder operates on the principle of deflecting a high-intensity U.V. light beam by means of mirror galvanometers across a moving strip of photographic paper. The paper is an immediate print-out type and requires no processing to develop the traces produced by the galvanometers.

There are two models available:

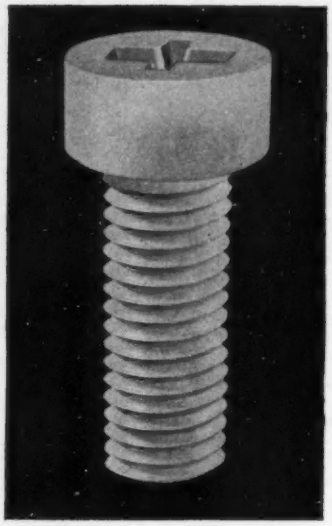
SE2000 accommodating up to 25 galvanometers writing on 6" wide paper.
SE2100 accommodating up to 50 galvanometers writing on 12" wide paper.

The only British Company offering a complete integrated system of Data Handling instrumentation.

For full details of these and other S.E. Laboratories products – transducers for pressure, acceleration and displacement, control and venting valves, frequency/DC converters, flowmeters, demodulators, carrier amplifiers, etc., contact:

S.E. LABORATORIES LIMITED

North Feltham Trading Estate, Feltham, Middlesex
Telephone: Feltham 5876



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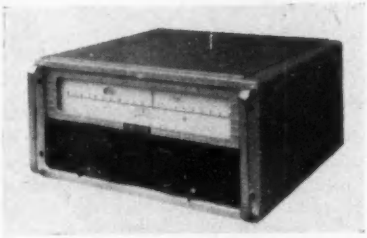


STRATTON & CO. LTD

Eddystone Works, Alvechurch Road, Birmingham 31

U.H.F. RECEIVER

(Illustrated above)

The model 770S is a new double conversion superheterodyne covering the frequency range of 500Mc/s to 1 000Mc/s. The calibration accuracy is within 1 per cent and a crystal calibrator provides 10Mc/s markers which enables frequency setting to 0·01 per cent. Bandspread tuning of ±10Mc/s is provided by tuning the second frequency changer. A 50Ω coaxial input is provided and the sensitivity is of the order of 10μV.

The receiver employs a first i.f. of 160Mc/s with a 20Mc/s bandwidth and a second i.f. of 46·5Mc/s; the overall bandwidth being 3Mc/s. A tuning and signal strength meter is provided.

EE 34 778 *for further details*

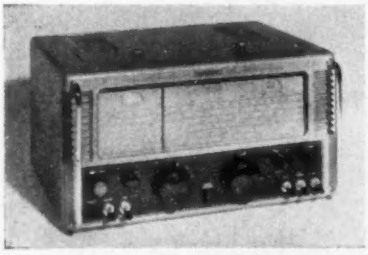
LOW FREQUENCY RECEIVER

(Illustrated below)

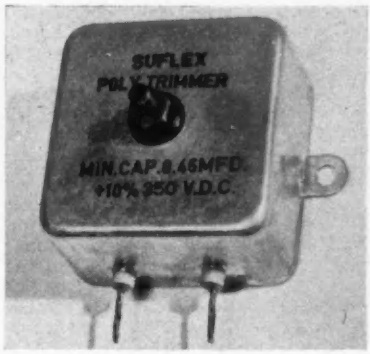
The low frequency receiver type S 850/2 has been designed to cover a frequency range of 10kc/s to 600kc/s in six overlapping ranges. Variable selectivity, crystal filters and an audio filter enable a high degree of discrimination to be obtained between received signals. Aerial inputs of 75Ω and 300Ω, balanced and unbalanced are provided and an a.g.c. circuit maintains the output level constant within 10dB for a change in input of 80dB above 10μV.

The audio response is flat within 6dB between 100c/s and 6kc/s and the maximum output into 2·5Ω impedance is approximately 1W. Phone output allows either high or low impedance phones to be used satisfactorily. A 600Ω output is provided which can be used balanced or unbalanced.

The sensitivity is better than 5μV for 15dB signal-to-noise ratio up to 100kc/s (signal modulated 30 per cent at 400c/s) and better than 15μV for 15dB signal-to-noise ratio at frequencies lower than 100kc/s.



EE 34 779 *for further details*



SUFLEX LTD

54 Uxbridge Road, London, W.5

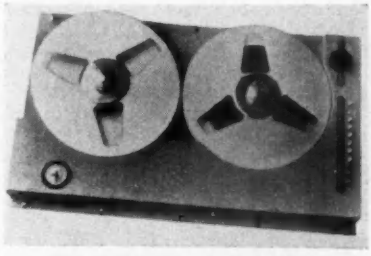
ADJUSTABLE POLYSTYRENE CAPACITORS

(Illustrated above)

These capacitors have been produced to meet the needs of a designer who requires a polystyrene capacitor which is adjustable over a small range.

The unit is in an hermetically sealed case 2in by 2in by 1¼in with a range of 0·45μF continuously variable to 0·5μF. The adjustment is by means of an Allen screw and the accuracy is within 0·1 per cent. Other values, with a 10 per cent variation of capacitance, are also available.

EE 34 780 *for further details*



THERMIONIC PRODUCTS (ELECTRONICS) LTD

Hythe, Southampton, Hampshire

EIGHT SPEED TAPE DECK

(Illustrated above)

This eight speed tape deck is intended for digital applications and is designed to give full coverage of all slow and medium speeds for magnetic recording. Speed change and deck functions are selected by push-buttons. Careful design of electrical interlocking completely eliminates the possibility of damage to tape or mechanism.

A precision tape driven footage indicator reading up to 10 000ft is fitted providing accurate place indication.

Head mounting and guidance arrangements have been designed with the utmost flexibility in mind. Provision has been made for mounting any number of heads up to four. If adjustable azimuth platforms are required the maximum number of heads which can be fitted is two.

Conventional tape guidance is normally fitted, but if a high packing density is required, single edge guidance may be fitted.

The deck will accommodate tape widths of ¼, ½ and 1in and speeds between ¼ and 15in/sec are provided.

EE 34 781 *for further details*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

FREQUENCY AND TIME MEASURING EQUIPMENT

(Illustrated below)

The TSA 3336 is a new and versatile time and frequency measuring equipment combining a comprehensive specification with a new projection type in-line read-out.

It includes transistor plug-in circuit modules from the Venner range and can be supplied with facilities for print-out, using the Venner transistorized digital printer type TSA 65, and punched tape record using the Venner transistorized reperforator control unit type TSA 101. It can also be supplied built-in to a complete data logging system.

The TSA 3336 has provision for measurement of frequency (events per unit time) up to 1Mc/s, inverse frequency (period), simple counting and time intervals in microsecond or larger units. In addition the outputs of the oven controlled 1Mc/s crystal oscillator and the digital divider chain are available for external use as 'clock' output pulses. The instrument may be reset remotely or by a panel mounted push-button or by an automatic delay timer.

The 1Mc/s crystal controlled oscillator drives seven decade divider stages. A further six decade divider stages are employed in a counting chain. Binary elements with feedback are employed throughout. Also included are associate gating, shaping and reset units from the Venner range.

The TSA 3336 incorporates a six digit in-line display with automatic insertion of the decimal point. In addition, a seventh indicator displays the units in use, e.g. kc/s, microseconds, etc. Moving scale indicators of a new patented design are employed. These present a clear unambiguous reading which can be viewed from a considerable distance and are not unduly directional. A red signal lamp mounted alongside the read-out indicates that the oven controlled thermostat is operating. Feather-light push-buttons operating microswitches are used in the 'Reset 0', 'Reset 9' and 'Stop' and 'Start' positions.

EE 34 782 *for further details*

Short News Items

At the Graham Clark Lecture given by H.R.H. the Duke of Edinburgh on 13 April at the Institution of Civil Engineers, television cameras and picture monitors were installed in the Institution's Great Hall and Lecture Theatre respectively by Rank Precision Industries Ltd. Using their mobile television studio unit as a control centre, and with the co-operation of the GPO, they relayed the entire proceedings to audiences in the Lecture Theatre of the Institution of Civil Engineers, the Institution of Mechanical Engineers' building in nearby Birdcage Walk and the Institution of Electrical Engineers' Headquarters in Savoy Place, Victoria Embankment. By this means a total of more than 2 000 people were able to watch throughout the proceedings.

A school for training engineers in the use of electronic equipment has been established by Associated Electrical Industries Ltd at New Parks, Leicester, headquarters of the Electronic Apparatus Division. Trainees include not only members of the company's Construction Department but also customers' engineers. At present there are two types of courses —the advanced, dealing with electronic machine tool control systems, lasting approximately five weeks, and an elementary course, on simpler equipments, over five days.

The British Space Development Company Limited announce that the following companies have become founder members: Associated Electrical Industries Limited, Associated Television Limited, British Insulated Callender's Cables Limited, Decca Radar Limited, Hawker Siddeley Aviation Limited, The Plessey Company Limited, Pye Limited, Rank Television and General Trust Limited, Rolls Royce Limited. Sir Robert Renwick has been appointed chairman. A technical committee has been set up under the chairmanship of Mr. G. K. C. Pardoe. The directors of the British Space Development Company Limited intend to examine ways and means by which this country shall assume a significant role in space technology. The task of the technical committee will be to examine and prepare plans designed to achieve British participation with the minimum of delay. Its first priority will be to submit proposals for the use of space for communications.

The Lord President of the Council and Minister for Science, Lord Hailsham, has appointed Sir Harold Roxbee Cox as Chairman of the Council for Scientific and Industrial Research for five years from 1 October 1961. He will succeed Sir Harry Jephcott, who has been Chairman of the Council since its formation under the D.S.I.R. Act of 1956, and who will complete his term of office in September. Sir Harold has been a member of the Council since 1957.

The Radio and Electronic Component Manufacturers' Federation is to hold an exhibition in the Marmorhallar, Stockholm, from 9 to 13 October 1961. This will be the fourth exhibition held in Stockholm by the British electronic component manufacturing industry. Previously timed for every five years, representations have been made from the Scandinavian countries that the exhibition should be held more frequently. Exports of British components last year increased by 36 per cent compared with 1959. Sales to Sweden (£1·1M) and Norway (£1·06M) were more than double the 1959 figure.

Air France and Air India International have ordered Cossor a.t.c. secondary radar transponder type SSR 1251 for installation in their Boeing 707 aircraft. These orders follow an earlier one from BOAC for the same equipment for their Boeing 707's. Thus three major international air lines have now adopted Cossor a.t.c. transponders. In the U.S. the carrying of secondary radar transponders is already compulsory for civil aircraft flying at altitudes above 25 000ft. Similar arrangements are under consideration for the U.K. and Western Europe. A secondary radar ground equipment also supplied by Cossor, is now being evaluated at London Airport by the Ministry of Aviation.

The Electrical Research Association have recently issued their annual report. It is noteworthy in that it is the 40th report to be issued; the Association having been founded in September 1920. In the year of its inception the Association had an income of £16 000 and an expenditure of £10 000. Today the Association has assets of over £1M and an annual expenditure of over £500 000; it occupies well equipped laboratories and undertakes research on a large and varied range of projects.

A noise research programme is being backed by Hawker Siddeley Aviation Ltd, who are to endow a readership and lectureship in noise and vibration research at the University of Southampton. This is the first industrial contribution in support of a new General Appeal Fund soon to be launched by the University. The Aeronautical Engineering Department of the University, under Professor E. J. Richards, has specialized in research associated with noise and vibration, specifically in relation to aircraft, land vehicles and ships. The department is receiving support for this type of research from many sources including, for example, the U.S. Air Force. In September, some members of the Engineering Department are going to Columbus, Ohio, to give a course on aeronautical acoustics. At Southampton, it is intended to establish a Master of Science course to extend the research into these subjects. The first course is planned to start in October. The University will also offer short courses in acoustical subjects.

The Institute of Physics and the Physical Society announces a residential symposium on 'Some aspects of the physics of space research' to be held at the Royal Military College of Science, Shrivenham, Swindon, Wiltshire, from 20 to 22 September 1961. The subjects to be discussed are: the advantages to physicists of space research; cosmic rays, particle physics and meterology; physical techniques in space research; and rockets, orbits and trajectories. Further details may be obtained from the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

The News of the World Organization Limited has agreed to purchase the whole of the issued share capital of Vactric (Control Equipment) Limited and Vactric (Precision Tools) Limited from the Receiver of Vactric Limited (in liquidation). New Boards of the above companies will be formed with Sir William Carr as chairman, and the present managing director, Mr. T. W. Roberts, will continue in that capacity. The Boards will also include Mr. G. Reed, Mr. P. J. Lawson and Mr. G. E. Edwards, the present executive directors. The management of the two companies therefore remains unchanged.

A radio telescope of the fully steerable type is to be built at a site near Crowthorne, Berkshire, by the Ministry of Works for the Radio Research Station of the Department of Scientific and Industrial Research. It is expected to be completed and in operation towards the

end of 1963 at an estimated overall cost of £250 000, including buildings, equipment and site services. The radio telescope, which will have a parabolic aerial about 80ft in diameter, is needed by the D.S.I.R. for their work in the space research programme and to study certain other aspects of radio science. It will have high accuracy and a faster tracking speed than the 250ft radio telescope at Jodrell Bank, an essential requirement for following earth satellites and determining orbital data. It will be used to receive weak signals from distant space vehicles transmitting at ultra-high frequencies. In the field of radio astronomy, an application of the telescope will be a study of radio noise from the sun, including sudden increases in radio emission which are related to disruption in short-wave communications. Also of interest is the radio noise from planets.

Telemechanics Ltd, of Totton, Southampton, have recently been appointed sole agents for the sale of all electronic equipments of Deutscher Innen Und Aussenhandel Elektrotechnik, Berlin, German Democratic Republic in the territories United Kingdom, Australia, Canada, New Zealand, Malayan Federation, Central African Federation of North and South Rhodesia and Nyasaland, Singapore and Portugal.

The Independent Television Authority have recently carried out trade test transmissions from two 750ft masts fitted with 40ft directional aerial arrays, supplied by EMI Electronics Ltd for the new Westward Television service which was due to commence programme transmissions on 29 April. One of the masts is situated 1 200ft above sea level at Caradon Hill, Bodmin, Cornwall. The aerial array is so designed to give strong signals throughout Cornwall without causing interference in Eire or France. The other mast—at Stockland Hill, Axminster, Devon—is 750ft above sea level. This aerial serves the Devon area, with restrictions in the directions of London and France. Two 1 000ft masts and aerial systems are also being provided by EMI Electronics for the ITA. One, at Lichfield, Staffordshire, due to come into operation in the early summer, will carry an 80ft directional aerial designed to improve independent television coverage in the Midlands. The other, at Durris, near Aberdeen, will carry a 90ft highly directional aerial array for the new ITV programme for the North of Scotland, provided by Grampian Television, which is scheduled to start transmissions next autumn.

Ultra Electric (Holdings) Ltd announce that an agreement has been signed between Ultra Electronics Limited, a subsidiary of Ultra Electric (Holdings) Ltd, and Electronics Investment Management Corporation of United States of America. Electronics Investment Management Corporation renders advisory and consulting services with respect to broad aspects of electronics industry and has an association with many companies in the forefront of electronic technology in the United States and elsewhere. This agreement provides for the interchange of information on the subjects of research, development, marketing and production of electronic equipment as well as other aspects in the electronic fields.

A Northern Computing Service, available for industrial, scientific and commercial calculations, has been set up at Manchester by Ferranti Ltd. Initially this service will be based on a Pegasus general-purpose digital computer at the company's head office at Hollinwood. Arrangements for using the service will be quite flexible, as at the Ferranti computing service centres in London. Clients may prepare their own programmes or hand over the complete job to the computing service staff.

Aveley Electric Limited of South Ockendon, Essex, have been appointed sole U.K. agents for the Bach-Simpson range of measuring, testing and control instruments. The Bach-Simpson Co. is a completely autonomous Canadian Co., producing the Simpson Line of instruments in Canada entirely from its own resources, but sharing with the Simpson Electric Co. (Chicago) joint engineering and mutually advantageous development projects. The Bach-Simpson merchandizing interests lie exclusively within Canada and the British Commonwealth. The range of instruments which will be available to the British market will include multi-range test equipment, panel mounted control indicators, frequency and running time meters, components, educational instruments, radio and television service equipment, laboratory apparatus, oscilloscopes and a wide range of portable instruments. Aveley Electric Limited will immediately introduce the Simpson type 260 and 270 Test Meters and the Bach-Simpson Control Indicator. Other instruments will be introduced at intervals.

Mullard Equipment Limited has been awarded the contract to supply a fully automatic telegraph switching system for the London Telegraph Centre of the Shell International Petroleum network. The equipment, which will be installed in the new Shell Centre on the South Bank, will be capable of handling over 1 000 incoming messages per hour. Messages awaiting transmission over busy circuits will be stored electronically and automatically re-transmitted as soon as the wanted lines become free.

A 'Sirius' digital computer has been ordered from Ferranti Ltd by Imperial Chemical Industries of Australia and New Zealand Ltd for use in their central research laboratory in Melbourne. The computer is a desk-sized transistorized general-purpose digital machine which can be installed by plugging into any ordinary electricity power point. Being a general-purpose machine, it is suitable for a wide variety of industrial, commercial, scientific and educational applications. The machine is easy to use. Decimal numbers are used throughout and can be displayed to the operator as such at any time while a simplified language for instructing or programming the machine, called Autocode, allows it to be used by people not specially trained as computer programmers.

The Westminster Bank Ltd has become the first British bank to install an electronic cheque sorter. The machine, supplied by The National Cash Register Company, was delivered on 9 April, to the clearing department at the bank's Lombard Street premises. The sorter, which automatically sorts mixed cheques and other documents at the rate of 750 per minute, was developed by N.C.R. in conjunction with Pitney-Bowes Inc. Over 100 machines of this type are already working in American banks. During sorting, the machine reads information imprinted on the cheques in magnetic ink. It uses the E13-B magnetic ink character system adopted in December last year by the London Clearing Banks.

Rivlin Instruments Ltd, who specialize in the manufacture of precision resistors, have recently trebled the area of their factory at Camberley, Surrey. They have also developed and introduced a new method of encapsulation, based on epoxy resin which has the following advantages: Wide temperature range with proof against high humidity—suitable for use in the temperature range of −55°C to +120°C with or without humidity, without significant effect on accuracy and stability. The new range is completely interchangeable with the existing RIL types (1-9) and all dimensions are exact and repeatable within very close limits. In accordance with the best of modern practice all terminations are gold plated to prevent oxidation during storage and to facilitate soldering without irksome preparation.

A precise length measuring equipment costing £16 000 has recently been delivered to the National Physical Laboratory at Teddington. Developed and produced at the Carl Zeiss Foundation in Western Germany, this instrument will measure length standards with an accuracy of 1 part in 10 millions or

better and is known as the Metre Interference Comparator. It has taken over three years to build and is one of the only two in existence. The other was recently supplied by Zeiss to the Physikalische-Technische Bundesanstalt at Brunswick (the national standards laboratory of the Federal German Republic). The Metre Interference Comparator uses the wavelength of monochromatic light as the invariable standard of length, and the phenomenon of wave-interference as the means of measurement.

Decca airfield control radar type 424 is to be supplied to the Portuguese Air Force, which will become the ninth air force to adopt this simple and practical radar landing aid. To meet the requirements of the Portuguese, the 424 will be mounted on a specially designed trailer to provide a self-contained and highly mobile landing control system. The trailer will incorporate the operators control position and will also be fitted with Ekco c.r.d.f. and Pye v.h.f. equipment. A separate diesel power trailer is being supplied for use in very remote areas; alternatively the equipment can be operated from suitable mains supplies where available.

The British Broadcasting Corporation has placed a further contract for two 100kW twin-channel high frequency sound broadcasting transmitters, valued at approximately £160 000 with Marconi's Wireless Telegraph Co. Ltd. These equipments are a departure from conventional design in that the penultimate and final r.f. amplifier valves and those of the modulator are vapour-cooled. The transmitters are scheduled for installation at the BBC External Services station at Daventry, for which two of the same types are already on order. A further two of somewhat similar design have recently been installed at the BBC's Rampisham (Dorset) station, making a total of six in all. Vapour-cooling is a system whereby the heat generated by the valves is transfered to water-jackets surrounding them. The resultant steam is taken by convection to a condenser which converts it once more to water for return by gravity feed to the water-jackets. The ability to effect a speedy changeover from one frequency to another is a highly desirable feature for high-frequency broadcasting services, and this aspect has received special attention in the design of the new equipments by the provision of two r.f. amplifiers per transmitter. These are contained in separate cubicles on either side of a common modulator, which is switchable to either. With the r.f. amplifiers set up on alternative frequencies a changeover can be made virtually instantaneously by switching the modulator output to the standby amplifier. The vapour-cooled valves used are manufactured by the English Electric Valve Company.

The Radio and Electronic Component Manufacturers' Federation have elected Mr. Arthur Bulgin (A. F. Bulgin & Co. Ltd) as president in succession to Mr. E. M. Lee (Belling & Lee Ltd). Mr. Bulgin was one of the six manufacturers who met in 1932 to form the Federation. Dr. G. A. V. Sowter (Telcon Metals Ltd) succeeds Mr. Hector V. Slade (Garrard Engineering & Manufacturing Co. Ltd) as chairman. Mr. Slade and Mr. K. G. Smith (N.S.F. Ltd) have been elected vice-presidents. The new Council is as follows: Belling & Lee Ltd, A. F. Bulgin & Co. Ltd, A. H. Hunt (Capacitors) Ltd, Multicore Solders Ltd, Painton & Co. Ltd, Plessey Company Ltd, Standard Telephones & Cables Ltd, Telcon Metals Ltd, and Bakelite Ltd (associate member).

Brussels National Airport, where the installation of the new 500kW Marconi 50cm surveillance radar is nearing completion have now placed an order with Marconi's S.A.I.T. Electronics for the delivery and installation of 18 fixed coil radar display units, to be manufactured by Marconi's Wireless Telegraph Co. Ltd. With this installation the Air Traffic Control Centre at Brussels National Airport will be provided with the most extensive display facilities ever installed on a civil airport in Continental Europe. In this way a complete coverage of a territory extending considerably beyond the frontiers of Belgium has been obtained.

'Radio Techniques and Space Research' is the title of the 1961 Convention of the British Institution of Radio Engineers. The Convention will be the first of its kind to be held in Great Britain; it will take place in the University of Oxford and last four days, 5-8 July inclusive. The Institution's decision to hold the Convention has been influenced by the value of discussion on the techniques and possibilities for satellite communications to those concerned with the "European Space Launcher Club". In addition to the use of satellites for communications the Convention will discuss research projects such as those which are to be carried out in the British satellite scheduled for launching by the American "Scout" Rocket towards the end of this year. The programme of the Convention will be made up of a number of sessions with the following titles: Radio Techniques in Space Research, Satellite Engineering, Extra-Terrestrial Measurements, Techniques in Radio Astronomy, Satellite Communications.

Correction

The maximum mean d.c. forward current of the Texas series 1S120 silicon signal diode quoted in the advertisement in the May issue, page 35, should read 200mA (at 25°C) and not 50mA.

PUBLICATIONS RECEIVED

FINGER KNOBS AND MOUNTINGS is an illustrated brochure describing the Plessey range of finger knobs and mountings for high quality industrial electronic equipment. In addition to dealing with supported units, the brochure contains interesting and important developments in unsupported and self-adjusting finger knobs. Copies are available from The Plessey Company Limited, Industrial/Electronic Component Sales, New Lane, Havant, Hampshire.

JMC STANDARD HEADED CONTACTS is a revised data sheet describing the Johnson Matthey standard range of contact rivets. The entire range is normally stocked in silver and, in addition, a limited range of sizes is now stocked in platinum, palladium, 40 per cent copper-palladium, 40 per cent silver-palladium, 10 per cent iridium-platinum, and Elkonite D54X. Further details and copies of data sheets are available free on request to the Company at 73-83 Hatton Garden, London, E.C.1.

SIMPLE OSCILLOSCOPE MEASUREMENTS, Parts 1 and 2, previously published as separate booklets by the Mullard Educational Service, have now been combined in a single publication. This addition to the "Simple Measurement Series" contains suggestions for 37 different experiments, which can be carried out using a simple oscilloscope. The experiments have been chosen to cover the syllabuses of schools, and the first year at technical college. This publication is now available, free of charge, to schools, technical colleges, official training establishments, and other interested organizations. Requests for copies should be addressed to Mullard Educational Service, Mullard House, Torrington Place, W.C.1.

A TRANSISTOR SUPERHETERODYNE RECEIVER is a report prepared for Standard Telephones & Cables Ltd by I. Aleksander. This unit is designed to be equal to or better than that of a valve portable receiver, with the added advantages of compactness and low running costs. Enquiries should be addressed to the Transistor Division of the Company at Footscray, Kent.

HIGH VACUUM VARIABLE CAPACITORS is a publication describing the range of high vacuum variable capacitors manufactured by the English Electric Valve Co. Ltd. At present, the series comprises five types covering capacitance ranges 5 to 30pF, 8 to 50pF, 16 to 80pF and 5·5 to 206pF, and this will be extended to meet future demands for alternative capacitance or voltage ratings. Further details are available from the Company at Chelmsford, Essex.

TUBE SEMICONDUCTOR SELECTION GUIDE, 1960-1961, by Th. J. Kroes, is the third edition of the book which has been revised to include several new features. The book is intended to enable the user of electron tubes or semiconductors to determine quickly which tube or semiconductor is to be preferred in the case in question. The book is published by Cleaver-Hume Press Ltd, 31 Wright's Lane, Kensington, W.8. Price 12s. 6d.

STC TRANSISTOR DIVISION have recently published four publications which give a summary of the products that they manufacture. They fall into categories as follows: (1) Transistors, (2) Signal Frequency Diodes, (3) Thermistors, and (4) Hermetic Seals. More comprehensive details are available for all the devices mentioned and enquiries should be addressed to The Sales Department, Transistor Division, Standard Telephones and Cables Limited, Footscray, Kent.

CONTROL FOR INDUSTRY has been produced for Lancashire Dynamo Electronic Products Limited, a member of the Metal Industries Group, as a review of the development which is already of importance to many branches of industry and of potential importance to many more. The publication describes the aims and methods of the Company and reviews the wide range of standard and other products now manufactured. Enquiries regarding this book should be addressed to Howard Panton Limited, Panton House, Howard Street, London, W.C.2.

WEIGHT-STRENGTH ANALYSIS OF AIRCRAFT STRUCTURES, by F. R. Shanley, is a paper-bound edition published by Dover Publications, price $2·45, which describes scientifically sound methods of analysing and predicting the structural weight of aircraft and missiles.

EE 34 130 *for further details*

BOONTON Radio Corporation
Hewlett-Packard Subsidiary

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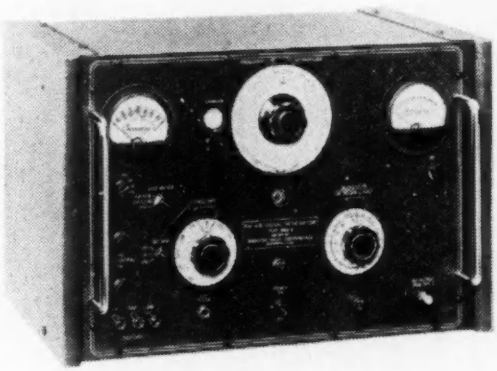

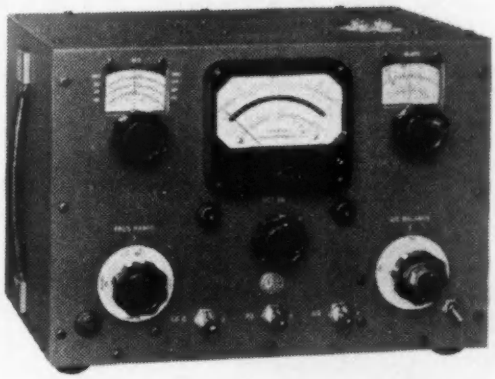

Q Meters	**Type** 260 AP 190 AP 280 AP	**Freq. Range** 50 KC to 50 MC 20 to 260 MC 210 to 610 MC	**Q Range** 10 to 625 5 to 1200 10 to 25,000	**Tuning Cap. Range** 30 to 460 μμf 7.5 to 100 μμf 4.0 to 25 μμf	**Q Accuracy** 5% to 30 MC 7% to 100 MC 20% to 610 MC		**Price** £ 370 £ 390 £ 950
Q Comparators	**Type** 265 A	**Freq. Range** 200 KC to 70 MC	**Q Range** 30 to 500	**L Range** 0.15 μh to 15 mh	**C Range** 5 μμf to .01 μf	**R Range** 500 Ω to 20 MΩ	**Price** £ 318
FM-AM Signal Generators	**Type** 202 E 202 G 225 AP	**Freq. Range** 54 to 216 MC 195 to 270 MC 10 to 500 MC	**Output Range** 0.1 μV to 0.2 V 0.1 μV to 0.2 V 0.1 μV to 0.1 V	**FM Mod.** 0 to 240 KC 0 to 240 KC 0 to 60 KC	**AM Mod.** 0 to 50% 0 to 100% 0 to 30%		**Price** £ 450 £ 440 £ 378
Sweep Signal Generators	**Type** 240 AP	**Freq. Range** 4.5 to 120 MC	**Output Range** 1 μV to 0.3 V Sweep 1 μV to 0.1 V CW & AM	**Sweep Range** ±1% to ±30% of center freq.	**AM Mod.** 30%	**Markers** crystal and pip.	**Price** £ 728
Transistor Test Set	**Type** 275 A	**α-Range** 0.100 to 0.9999	**β-Range** 7 to 200	**Hib Range** 0.30 to 3000 Ω			**Price** £ 374
RX Meters	**Type** 250 A	**Freq. Range** 500 KC to 250 MC	**R Range** 15 Ω to 100 000 Ω	**C Range** 0 to 20 μμf	**L Range** 0.001 μh to 100 mh		**Price** £ 610
Signal Generator Calibrators	**Type** 245 C 245 D	**Freq. Range** 500 KC to 1000 MC 500 KC to 1000 MC	**Calibrated Input** 0.025, 0.05, 0.1 V 0.025, 0.05, 0.1 V	**Calibrated Output** 5, 10 or 20 μV 0.5, 1.0 or 2.0 μV	**% AM Range** 10–100% 10–100%		**Price** £ 156 £ 154
Univerters	**Type** 207 EP 207 GP 203 B	**Freq. Range** 100 KC to 55 MC 100 KC to 55 MC 100 KC to 25 MC	**Output Range** 1 μV to 0.1 V 1 μV to 0.1 V 1 μV to 0.1 V	**FM Mod.** 0 to 240 KC 0 to 240 KC 0 to 15 MC	**AM Mod.** 0 to 50% 0 to 100% 30%	**Accessory to** 202 E 202 G 240 AP	**Price** £ 172 £ 208 £ 168

BRC Precision Test Equipment is engineered and manufactured to the highest standards of the industry – standards that have made the BRC trademark a recognised symbol of precision and dependability throughout the world.

Prices delivered U. K. exclusive of duty where payable. Continuous progress in design may affect the above specifications which are therefore subject to change without notice. For information, technical sales and engineering help, or a demonstration please write or call

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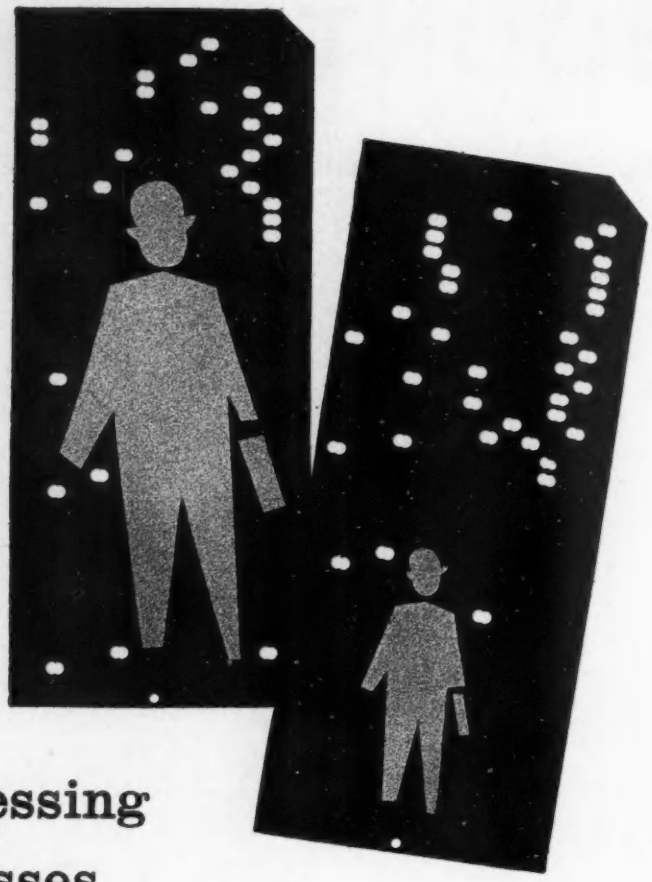
EE 34 131 *for further details*



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I·C·T 40-column equipment records the data of your business in the 40 columns of the I·C·T punched card. It uses these cards to sprint through routine business operations. It streamlines the working of organisations large and small: from firms employing less than 100 to undertakings as large as the G.P.O. telephone accounting system—and all sizes in between.

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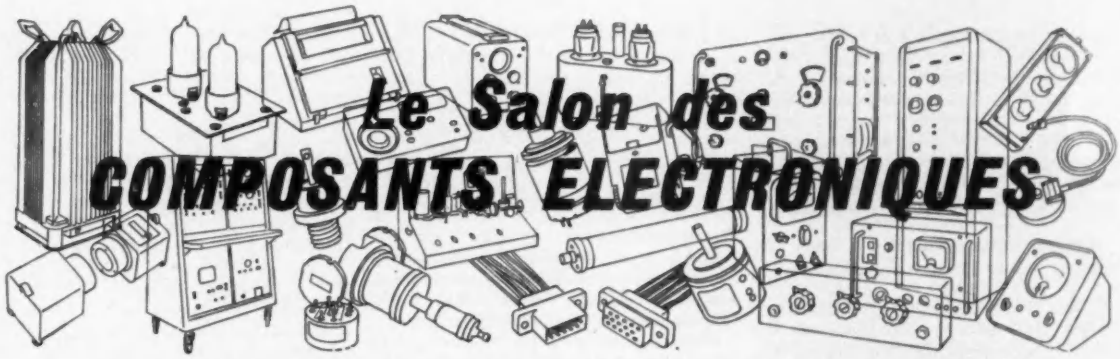

Le Salon des COMPOSANTS ÉLECTRONIQUES

Le Salon des Composants Electroniques. Une description, basée sur des renseignements fournis par les fabricants, d'un choix de matériels exposés au Salon de la Fédération des Fabricants de Composants Electroniques et de Radio, à l'Olympia de Londres, du 30 mai au 2 juin 1961.

Traduction des pages 390 à 395

AIRCRAFT-MARINE PRODUCTS (GREAT BRITAIN) LTD

Ample House, 87-89 Saffron Hill, London, E.C.1

NOYAUX DE FERRITE À PLUSIEURS OUVERTURES

(Illustration à la page 390)

Un dispositif AMP-MAD à plusieurs ouvertures emploie des noyaux magnétiques de forme spéciale utilisant des matières en ferrite à boucle d'hystérésis rectangulaire dans lesquelles un certain nombre de petits trous sont disposés autour d'une ouverture plus importante.

Ces dispositifs peuvent servir au stockage de données numériques ou analogiques. Ils ont la propriété particulière de pouvoir fournir des lectures intrinsèquement non-destructives de données emmagasinnées grâce à la disposition géometrique et magnétique correcte de petites ouvertures autour d'une grande ouverture.

Les principes de fonctionnement sont brièvement les suivants: La commutation de flux commence au diamètre intérieur (ou parcours magnétique le plus court) d'un noyau toroïdal et s'étend vers l'extérieur jusqu'au diamètre extérieur (parcours magnétique plus long) jusqu'à ce que le champ de flux soit entièrement inversé. Pour une matière donnée, le seuil de commutation peut être abaissé en diminuant le diamètre intérieur du noyau, et relevé en augmentant le diamètre intérieur. L'induction de saturation peut être effectuée en appliquant la même règle au diamètre extérieur. Par un contrôle précis de la matière en ferrite, on peut établir un rapport linéaire entre le flux de commande et le flux rémanent, le seuil de petite ouverture devenant nettement inférieur au seuil de grande ouverture puisque la longueur de son parcours est plus réduite.

Contrairement aux noyaux toroïdaux classiques, un noyau MAD est "réglé" en inversant la moitié du flux rémanent total. En appliquant la pleine commande de "réglage" à un noyau préalablement dégagé, le flux rémanent est inversé sur l'ouverture principale jusqu'à un point se trouvant à mi-chemin entre les diamètres intérieur et extérieur du noyau. A ce moment-là, le flux rémanent se trouvera dans une direction opposée au sens des aiguilles d'une montre sur la branche intérieure et dans le sens des aiguilles d'une montre sur la branche extérieure du noyau. Le débit intrinsèque non-destructif d'un noyau MAD est une caractéristique de ses ouvertures mineures dans la position "réglée". Lorsqu'une ouverture mineure est filetée avec un enroulement primaire (commandé) et secondaire (débit), une lecture non-destructive continue peut être obtenue sur le transformateur de l'enroulement de débit-couplé à son enroulement primaire par la branche extérieure de l'ouverture mineure. Dans l'état "réglé", la commande appliquée à l'enroulement primaire de l'ouverture mineure commute le flux localement autour de l'ouverture mineure et elle est ajustée à une valeur inférieure au niveau de seuil de l'ouverture majeure. Dans l'état "dégagé" et avec une commande contrôlée de l'ouverture mineure, le flux rémanent ne peut être commuté autour de l'ouverture mineure et aucun débit ne peut donc se produire. Le flux commuté autour d'une ouverture mineure ne détruit pas l'état "réglé" du noyau.

EE 34 751 *pour plus amples renseignements*

ANTIFERENCE LTD

Bicester Road, Aylesbury, Buckinghamshire

ANTENNE DE GRENIER

Cette nouvelle antenne de grenier, type HL 514, est livrable pour toutes les combinaisons de canaux dans la Bande I/III pour la polarisation verticale. Il est muni d'un double rideau comprenant un dipôle télescopique unique pour les éléments de la Bande I et de la Bande III. L'antenne est complète avec bras à angle et support.

EE 34 752 *pour plus amples renseignements*

COMPENSATEUR

Ce nouvel appareil est un "atténuateur sensible à la fréquence" et il a été étudié pour pouvoir être intercalé facilement dans les descentes d'antenne de télévision afin de produire une atténuation variable des signaux de la Bande I sans affecter la Bande III, ou des signaux de la Bande II sans affecter la Bande I, permettant ainsi d'obtenir facilement un signal équilibré dans les zones où les différences d'emplacement des émetteurs ou des conditions différentes de puissance ou de réception provoquent un signal inégal.

EE 34 753 *pour plus amples renseignements*

ASHBURTON RESISTANCE CO. LTD

72 Brewery Road, London, N.7

RÉSISTANCES DE CIRCUITS IMPRIMÉS

Ces résistances de précision ont été spécialement conçues pour être utilisées dans des circuits imprimés. La résistance ERP1 a été réalisée en vue de résoudre le problème des conducteurs d'extrémité fracturés, qui se pose souvent lorsque les résistances sont montées sur des plaquettes de circuits imprimés. La résistance ERP1 se caractérise, entre autres, par de solides fils de liaison d'extrémité radiale en cuivre étamé de 0,81 mm de diamètre.

La ERP1 a un régime nominal d'un dixième de watt et elle destinée aux grilles modulaires de 2,54 mm, ayant une distance entre les centres des extrémités de 10,1 mm. Des tolérances de rouge, vert, jaune et bleu (±1, 0,5, 0,25 et 0,1% respectivement) sont prévues.

Ce système de code de couleurs, récemment introduit par la société Ashburton pour l'identification rapide et précise des tolérances est utilisé sur toutes les résistances de précision Arcol.

La ERP1 est actuellement sous moulage de résine d'époxyde.

EE 34 754 *pour plus amples renseignements*

RÉSISTANCES DE SERVICE CONTINU

(Illustration à la page 390)

La société Ashburton a introduit des résistances de 200 à 750 W dans sa gamme de résistances de service continu. Leur enrobage est en acier à persiennes ou perforé, et divers finis sont prévus.

L'enrobage protège les parties sous tension des résistances, de manière à ce qu'elles puissent être montées sans danger à l'extérieur d'un appareil, mais les plaquettes de connexions restent d'un accès facile.

Deux types d'enrobage sont prévus, l'un avec persiennes verticales et l'autre avec persiennes horizontales. Ainsi, une résistance de service continu peut être montée soit verticalement soit horizontalement à l'intérieur d'un appareil et le bobinage sera toujours protégé contre les égouttures dues à la condensation.

EE 34 755 *pour plus amples renseignements*

BADER MACHINERY CO. LTD

Hersham Factory Estate, Walton-on-Thames, Surrey

Cette société produit un gamme étendue de matériels automatiques à action rapide pour la fabrication de semi-conducteurs, de lampes incandescentes, de lampes de radio et de tubes cathodiques. Les machines suivantes sont caractéristiques de la variété des appareils offerts:

MACHINE D'EMBOUTISSAGE DE DIODES À 16 TETES

Cette machine est munie d'une boîte de changement de vitesses complètement enfermée, avec des rouleaux coniques en acier trempé et meulé s'enclenchant dans une came à diviser tridimensionnelle de type cylindrique, coupée pour garantir l'accélération et le ralentissement constants. Les têtes de scellement tournent dans les positions appropriées et sont commandées par un mécanisme à part d'entraînement de vitesses variables. Tous les principaux roulements de la machine sont huilés automatiquement à partir de la position centrale et toutes les trémies d'alimentation ainsi que les autres pièces en contact avec les composants sont d'un poli parfait, des carters en plexiglass étant prévus, en outre, pour protéger les pièces dans les trémies des pénétrations de poussières, etc. La vitesse de division maxima est de 2000 coups par heure, c'est à dire que le rendement maximum est de 4000 sous-ensembles par heure. La séquence du fonctionnement est comme suit:

(a) Alimentation automatique des électrodes soit à partir d'une bobine soit à partir d'une trémie utilisant des électrodes pré-coupées. Lorsque les électrodes sont alimentées par bobine, un dispositif redresseur et un appareil coupeur sont fixés à la machine pour assurer la précision des composants.

(b) Charge automatique des perles de verre pré-taillé à partir d'une trémie.

(c) La perle est scellée à l'électrode par des becs de gaz et, durant le processus de scellement, les têtes tournent à grande vitesse pour produire une obturation concentrique.

(d) Le composant complet est automatiquement déchargé dans des chargeurs contenant 50 positions, les chargeurs étant chargés à la main puis automatiquement divisés par le point de décharge.

(e) Au cas où il n'y aurait pas de composants dans les têtes, les chargeurs ne divisent pas, de façon à ce que tous les chargeurs quittant la machine soient pleins.

(f) Une position de nettoyage de tête est prévue après la position de décharge et permet à un jet d'air comprimé de nettoyer à fond la tête avant de charger de nouveaux composants.

(g) Les pistes à chargeurs peuvent recevoir trois chargeurs, un chargeur plein étant livré au point de décharge, à peu près à chaque minute et demie.

EE 34 756 *pour plus amples renseignements*

FOURS D'ALLIAGE DE DIODES

Deux types de four standard sont livrables soit le modèle à tunnel horizontal et le four vertical, tous deux offrant des avantages spécifiques.

Dans le four d'alliage, des chargeurs remplis de sous-ensembles sont déplacés vers deux zones chauffées électriquement, à savoir une zone de préchauffage et une zone à température élevée (variant entre 200°C et 800°C). Des ouvertures de gaz inerte permettent au gaz inerte d'être injecté dans le four pour fournir une atmosphère de projection. Au cours du processus de soudure, la boulette de soudure se fond et le poids presse sur la pastille pour former une bonne jonction avec l'électrode. Le four est muni du contrôle automatique de température, afin de pouvoir maintenir à l'intérieur du four une température qui soit à 5% près celle du réglage du cadran.

Après alliage, les chargeurs sont transférés vers une zone de refroidissement où la temperature du chargeur est ramenée à environ 20°C. C'est la "station-tampon" qui refroidit le chargeur pendant la période de temps voulue. Après refroidissement, l'opérateur retire les chargeurs, prêts pour l'opération suivante. Tandis qu'il retire les chargeurs, il permet aux poids de tomber, pour qu'ils puissent être retournés pour un nouvel usage.

EE 34 757 *pour plus amples renseignements*

BIRMINGHAM SOUND REPRODUCERS LTD

Monarch Works, Old Hill, Staffordshire

PHONOGRAPHE

(Illustration à la page 391)

Le phonographe GUG est un appareil compact à vitesses de 16, 33⅓, 45 et 78 tours/minute. Il est muni d'un arrêt automatique pour la fin de chaque disque et d'un désengreneur automatique de la roue à poulie de tension en caoutchouc lorsque le phonographe est débranché. Il est monté sur ressorts afin de réduire la résonance du coffret et le pleurage, le flottement et le grognement sont, semble-t-il, virtuellement inexistants. Le pick-up peut recevoir n'importe quelle cartouche de la gamme B.S.R. "Ful-Fi".

EE 34 758 *pour plus amples renseignements*

DAWE INSTRUMENTS LTD

99-101 Uxbridge Road, Ealing, London, W.5

PHASEMÈTRE TRANSISTORISÉ

(Illustration à la page 391)

Le phasemètre Type 630 est un instrument entièrement transistorisé à alimentation secteur ou batterie qui mesure les différences de phase entre deux sources de signaux. Deux amplificateurs limiteurs sont alimentés respectivement par les entrées de signal et de référence. Les sorties qui en résultent sont différencées et des impulsions positives sont obtenues avec le même rapport de phases que les signaux d'entrée. Les impulsions de l'un des amplificateurs branchent un circuit bistable et celles de l'autre amplificateur le coupent. Le rapport repère/espace de la forme d'onde rectangulaire que l'on obtient ainsi est directement proportionnel à la différence de phase entre les sources d'entrée et il est exprimé directement sur un appareil de mesure à cadre mobile.

La gamme de fréquences va de 1 Hz à 25 kHz et les gammes d'angle de phase sont: 0° à 360° et 180°-0-180°. Le degré de précision avec des signaux equilibrés est de ±3°.

EE 34 759 *pour plus amples renseignements*

VIBROMÈTRE TRANSISTORISÉ

(Illustration à la page 391)

Le vibromètre à transistors type 1431 comprend un capteur de vibrations, un amplificateur à gain élevé comportant des circuit intégrateurs et différenciateurs et un affaiblisseur réglable, ainsi qu'un appareil de mesure indicateur à lecture directe. Ce vibromètre portatif transistorisé a été conçu pour mesurer les trois principales caractéristiques d'une vibration, c'est à dire le déplacement, la vitesse et l'accélération. Il est d'un apport précieux pour toutes les étapes des travaux de recherche, d'étude et de production, lorsqu'on veut éviter les effets nuisibles de l'usure et du fonctionnement bruyant.

Le capteur de vibrations type 1403/1 fourni avec l'instrument est du type à cadre mobile et donne une sortie proportionnelle à la vitesse du mouvement étudié. L'instrument est à alimentation autonome par batterie et peut être également utilisé sur courant secteur ordinaire.

Gammes de vibrations:

Déplacement: sept gammes, de 0 à 0,0076 mm jusqu'à 0 à 0,76 mm de zéro à la crête.

Vitesse: neuf gammes, de 0 à 0.076 mm/sec jusqu'à 0 à 76,2 cm/sec à la crête.

Accélération: cinq gammes, de 0 à 254 cm/sec² jusqu'à 0 à 254 m/sec² à la crête.

Gammes de fréquences: 50 Hz à 2000 Hz.

Il existe aussi un vibromètre étalonné en unités métriques.

EE 34 760 *pour plus amples renseignements*

ELECTRONIC COMPONENTS LTD

Weedon Road, Industrial Estate, Northampton

MÉLANGEUR À QUATRE CANAUX

(Illustration à la page 392)

Cet instrument a été étudié pour satisfaire à la demande d'un mélangeur multicanaux compact et d'une tenue appropriée aux besoins professionnels. Il est, en plus de cela, d'un prix des plus attrayants pour l'amateur.

Le circuit de l'instrument s'inspire de l'affaiblisseur électronique Elcom et a été perfectionné de manière à combiner la simplicité avec un bon comportement.

Les possibilités qu'offre cet instrument sont: quatre entrées séparées à impédance élevée dans des préamplificateurs à gain de 20 dB et comportant le gain préréglé, l'amplification des basses fréquences et des fréquences élevées et la coupure. Chaque canal est commandé par un affaiblisseur du type à quadrants, permettant le gain progressif ou l'affaiblissement progressif séparés, dans la gamme de 0 à 60 dB et hors circuit. A partir de cette dernière position, chaque affaiblisseur de canal a une position de pré-écoute permettant au contrôleur d'écouter sur un canal choisi, lorsque ce canal est hors-circuit par rapport au mélangeur. Le contrôleur peut alors amplifier facilement et rapidement le canal lorsqu'il entend l'indication voulue. Ce dispositif est lié à l'ouverture du contrôleur acoustique décrit ci-après.

Les quatre canaux sont combinés dans un mélangeur et commandés par un atténuateur principal du type à quadrants, une fois encore en fonction de la gamme 0 à 60 dB et hors-circuit. La sortie mélangée et contrôlée est normalement fournie à une impédance de 600. Des impédances de sortie plus élevées peuvent être fournies sur commande.

Le contrôle visuel du niveau de pointe peut être effectué avec ce mélangeur. Il existe aussi une ouverture allant du signal mélangé final à 5 kΩ jusqu'à une douille de jack pour l'appréciation acoustique et la pré-écoute.

Les affaiblisseurs de canaux et principaux sont munis de voyants de couleur de signalisation indiquant une lumière verte pour le canal hors circuit et une lumière rouge pour le canal en circuit.

Le mélangeur a un chiffre de distorsion harmonique totale supérieur à 0,25%. Le rapport signal/bruit est supérieur à 70 dB et la réponse de fréquence est suffisante de 40 Hz à l'audibilité et bien au-delà.

Une particularité importante de ce mélangeur est l'emploi d'éléments à fiches pour les parties individuelles du circuit et des affaiblisseurs, de sorte qu'en cas de panne, l'isolement peut être rapidement établi et un élément de réserve peut être enfichée.

Une alimentation extérieure à 12 V c.c. est nécessaire tant pour le circuit électronique que pour les voyants de couleur, les deux circuits étant conduits séparément à une fiche pour permettre l'emploi d'une alimentation de faible capacité pour le fonctionnement de la partie électronique en usage portatif ou "sur place".

EE 34 761 *pour plus amples renseignements*

GARDNERS RADIO LTD

Somerford, Christchurch, Hampshire

TRANSFORMATEURS D'ISOLEMENT

(Illustration à la page 392)

Afin de répondre aux diverses demandes d'appareils ménagers, de petites machines, d'éclairage à faible tension, etc. la société Gardners produit une nouvelle gamme de transformateurs d'isolement portatifs à bobinage automatique et à tension réduite appelés "Série Castle".

Pour simplifier la réalisation, les enroulements sont étudiés pour une entrée normale de 230-240 V, mais des transformateurs pour d'autres tensions d'alimentation peuvent être fournis sur commande spéciale. Les transformateurs à double enroulement types CAS. 900 et CAS. 916 sont à prises centrales conformément à la réglementation de sécurité et sont munis d'un écran électrostatique entre les enroulements. Tous ces transformateurs sont calculés pour le fonctionnement continu et dans les cas où ils sont nécessaires pour le fonctionnement intermittent, c'est à dire, par exemple, de courtes périodes de fonctionnement avec des périodes égales de repos, la puissance nominale suivante peut généralement être choisie. Chaque transformateur est fourni avec 1,828 m de câble souple pour la jonction d'entrée et une fiche appropriée pour l'alimentation de sortie. L'entrée est fondue avec un fusible du type à vis, facilement remplaçable.

Les versions à double enroulement de ces transformateurs sont fournies avec des indices nominaux de sortie de 12 V, 12 VA à 110 V, 500 VA et 240 V, 200 VA. Les versions à bobinage automatique fournissent une sortie de 115 V à partir de 25 VA jusqu'a 550 VA.

EE 34 762 *pour plus amples renseignements*

GENERAL CONTROLS LTD

13-15 Bowlers Croft, Honeywood Road, Basildon, Essex

POTENTIOMÈTRES HÉLICOÏDAUX

(Illustration à la page 392)

Les potentiomètres hélicoidaux PK15 et PM15 constituent une série d'instruments miniature de précision à trois et à dix spires. Leur caractéristique dominante est la précision d'un aussi petit dispositif helicoïdal avec une valeur maximum de 120 kΩ sur dix spires et de 40 kΩ sur trois spires.

Il est muni de butoirs d'extrémité positifs et peut être fourni avec roulements à billes ou boîtes de roulement, servo-supports ou supports à douilles. La meilleure linéarité pratique pour les commandes spéciales est de ±1%. Le diamètre du corps est de 2,222 cm et la longueur totale est de 3,73 cm sur le modèle à 10 spires.

La série PK 30 et PM 30 comprend des potentiomètres hélicoïdaux de précision à trois et à dix spires avec une valeur maximum de 150 kΩ pour les trois spires et de 500 kΩ pour les dix spires. Les potentiomètres sont munis de butoirs d'extrémité positive et peuvent être dotés de boîtes de roulements ou de roulements à billes. Ils peuvent être fournis pour servo-supports ou supports à douilles. Le diamètre du corps est de 4,60 cm et pour le potentiomètre à dix spires la longueur totale est de 5,08 cm. La longueur totale du modèle à trois spires est de 3 cm. La meilleure linéarité pratique pouvant être atteinte pour la valeur choisie est de 0,05%.

EE 34 763 *pour plus amples renseignements*

COMPTEURS DE SPIRES

(Illustration à la page 392)

Le compteur de tours CM-3 est un auxiliaire précieux pour déterminer la position de composants rotatifs de précision, tels que les potentiomètres multitours et les condensateurs variables. Un cadran numérique grand et clair, donne une lecture directe au coup d'œil et indique la position exacte du dispositif multitours.

Un couple constant donne à l'instrument une grande sensibilité et permet, par conséquent, des réglages extrêmement précis. La rotation douce de toutes les parties mobiles, avec le minimum de jeu, garantit une lecture précise du moindre changement ou mouvement de l'arbre principal.

Le compteur CM3 est livrable en trois modèles à cadrans numériques, facilement adaptables à des dispositifs rotatifs jusqu'à un maximum de dix tours (3600°). Les lectures indiquent le pourcentage de rotation totale, les tours complets, les dixièmes et les centièmes.

On envisage pour plus tard la production de six modèles pour axes de 0,635 et 0,317 cm.

EE 34 764 *pour plus amples renseignements*

SERVO-POTENTIOMÈTRE

(Illustration à la page 392)

Toutes les pièces de ce potentiomètre de précision de conception américaine sont usinées avec le plus grand soin et comportent des roulements à billes fixés dans le couverde et à la base afin de garantir le minimum de jeu latéral et d'extrémité sur couple d'axe et de fonctionnement réduit.

L'angle de résistance efficace sur le modèle courant est de 300° mais il peut être porté à 355° sur commande spéciale. La valeur maxima est de 200 kΩ sur bobinage à carte. La linéarité indépendante peut être maintenue à 0,25% le cas échéant.

Mesurant 4,603 cm de diamètre sur une profondeur de 3,095 cm et ayant un régime nominal de 4 W sur un bobinage à carte et de 2 W sur un bobinage en forme Lewmex, ce servo-potentiomètre peut être produit également comme fil à contact glissant avec linéarité infinie jusqu'à 10. Les extrémités du bobinage sont soudées à des pattes de fusion pour plus de précision et de stabilité.

Le potentiomètre est muni de pattes de fixation à barillet argentées, avec un contact à souder en métal précieux d'alliage 292, et il peut être jumelé à un maximum de six éléments.

EE 34 765 *pour plus amples renseignements*

THE GOLDRING MANUFACTURING CO. (GREAT BRITAIN) LTD

486-488 High Road, Leytonstone, London, E.11

TOURNE-DISQUES FONCTIONNANT SUR BATTERIE

(Illustration à la page 393)

Ce tourne-disques phonographique à quatre vitesses, fonctionnant sur batterie, est muni d'un mécanisme d'arrêt automatique et il est actionné par un moteur à courant continu à six pôles dont la

consommation électrique est très faible. Une vitesse constante est maintenue dans une gamme de tensions de 5 à 9 V. Le tourne-disques de 20,32 cm est à moitié encastré et les dimensions hors-tout sont de 22,86 cm sur 27,94 cm. L'appareil est fourni complet avec bras de pick-up et cartouche.

EE 34 766 *pour plus amples renseignements*

HELLERMANN LTD

Crawley, Sussex

GAINES DE SERRAGE ET DE MARQUAGE POUR CABLES

Trois nouveaux types de gaines de câbles ont été réalisés par la société Hellermann. Ce sont:

Le type Helsyn 150

Cette nouvelle gaine a été créée en fonction de la demande accrue de meilleurs résultats. Le type Helsyn 150 remplace le type Helsyn 100 car il a un facteur de résistance beaucoup plus élevé à la chaleur, aux fluides et à l'ozone.

Le type Helsyn TX

Les gaines et marqueurs Helsyn TX remplaceront le type Helsyn actuel par suite de leur propriété de résistance très élevée à l'ozone. Ils sont profilés à partir d'un composé à base de néoprène, n'ont aucune teneur en caoutchouc et répondent pleinement aux conditions de la spécification DEF.20.

Twintex

Twintex est un nouveau type de gaine Hellermann, mis au point avec des qualités de résistance aux températures élevées et aux fluides, supérieures à celles des gaines Helaprene.

EE 34 767 *pour plus amples renseignements*

THE LEWIS SPRING CO. LTD

Resilient Works, Redditch, Worcestershire

BRIDES DE TRANSISTORS

Le série des brides de transistors L.S. fabriquées avec du cuivre de béryllium et étudiées de manière à contribuer à la dissipation de chaleur, s'adapte aux transistors cylindriques tels que les types Mullard OC72, SB345 et OC170. Ces brides peuvent être fixées horizontalement, avec aisance et rapidité, sur des plaquettes de circuits imprimés à travers des trous de 0,396 cm de diamètre.

EE 34 768 *pour plus amples renseignements*

MARCONI INSTRUMENTS LTD

St. Albans, Hertfordshire

OSCILLATEUR RÉSISTANCE-CAPACITÉ À GAMME ÉTENDUE

(*Illustration à la page 393*)

Cet oscillateur à pont de Wien couvre la gamme de 10 Hz à 10 MHz (onde sinusoïdale) en six bande de décades. La bande supérieure, dont la portée exceptionnellement étendue va de 1 à 10 MHz et dont les caractéristiques de sortie sont très stables, convient au contrôle de réponse dans les bandes vidéo et haute fréquence inférieure. Une échelle unique est utilisée pour les quatre fréquences inférieures et quatre échelles séparées pour les deux bandes supérieures, ce qui donne une longueur d'échelle totale de 266 cm et rend un changement de fréquence de 1% facile à déceler. La vitesse et la précision de l'accord s'allient à une commande à double rapport, c'est à dire 3 : 1 pour le réglage rapide et 18 : 1 pour l'accord précis.

Des puissances de sortie de 1 mV à 3,16 V peuvent être obtenues au moyen d'un atténuateur à commutation franchissant 60 dB par plots de 10 dB. Le niveau du signal appliqué à l'entrée de l'atténuateur est à variation continue et il est contrôlé par un appareil de mesure étalonné en tension, en circuit ouvert et en décibels. L'impédance de sortie peut être réglée à 75, 100 ou 600 ohms. Des sorties réduites jusqu'à 10 μV, à 75 ou 5 ohms, peuvent être obtenues à l'aide d'un dispositif d'affaiblissement fourni comme accessoire facultatif. Des sorties élevées allant jusqu'à 31,6 V, à des fréquences inférieures à 100 kc/s, sont fournies sur une sortie à part.

Cet instrument convient particulièrement à l'emploi avec des lignes de transmission, des filtres, des atténuateurs, etc. Parmi ses autres applications, comme générateur d'ondes sinusoïdales, il faut ajouter la fourniture de la tension d'excitation aux ponts basse-fréquence et haute fréquence.

Le TF 1370 fournit aussi une sortie d'ondes carrées de haute qualité allant jusqu'à une pointe de 31,6 V, à des fréquences de 10 Hz à 100 Hz.

EE 34 769 *pour plus amples renseignements*

MILLIVOLTMÈTRES À LARGE BANDE

(*Illustration à la page 393*)

Une gamme de fréquences étendue (30 Hz à 30 MHz), alliée à la stabilité, à la précision et à la sensibilité, donnent à ce voltmètre une très grande souplesse d'emploi. La gamme de tensions va de 100 μV à 300 mV, ou jusqu'à 30 V avec un multiplicateur facultatif.

Le TF 1371 peut mesurer des tensions alternatives réduites, des fréquences d'alimentation jusqu'au seuil des hyperfréquences. Il peut être employé avec des amplificateurs haute-fréquence, moyenne-fréquence, vidéo et basse-fréquence. Il permet de mesurer des niveaux de signaux dans les récepteurs hyper-fréquences, de l'antenne au haut-parleur.

Son appareil de mesure de 12 cm répond à la valeur moyenne d'une forme d'onde alternative et il est étalonné à la valeur efficace d'une onde sinusoïdale. Il est muni de deux échelles de millivolts ainsi que d'une échelle indiquant les décibels relatifs à 1 mW dans 600 ohms. Afin de maintenir la précision de façon prolongée, l'étalonnage peut être aisément normalisé en fonction d'une source intérieure.

EE 34 770 *pour plus amples renseignements*

CALIBRE À CRISTAL DE PRÉCISION

(*Illustration à la page 393*)

Le TF 1374 qui couvre la gamme de fréquences de 100 kHz à 1500 MHz avec une stabilité de 1 partie dans 10^6 par mois, fournit des points de contrôle piézoélectrique de précision sous forme de battements nuls au casque. Les points se produisent à intervalles choisis par commutateur de 10 MHz, 2 MHz, 500 kHz ou 10 kHz. Chaque série de points est fournie séparément, et elle est entièrement exempte de battements sous-harmoniques. Les points de 100 kHz sont clairs et distincts jusqu'à 500 MHz au moins, et les points de 10 kHz sont utilisables jusqu'à 10 MHz. Des tensions de sortie sont livrables à chacune des fréquences de contrôle.

La précision, la simplicité du fonctionnement et les points de contrôle, clairement identifiables et sans battements parasites intermédiaires qui caractérisent cet instrument, le rendent idéal pour des applications telles que la normalisation des générateurs de signaux et des oscillateurs ou l'établissement de fréquences d'emission HF, VHF et UHF. Ses sorties de fréquence étalon peuvent être utilisées pour étalonner des récepteurs ou des ondemètres. La gamme de fréquences propre au contrôle des récepteurs dépend de la sensibilité, de l'image et de la pénétration MF, mais avec des récepteurs moyens elle peut être utilisée jusqu'à 100 MHz au moins.

Dans une version constituant une variante, à savoir le type TF 1374/1, la série de points piézoélectriques de contrôle a été remplacée par des points de 25 kHz, utilisables jusqu'à environ 200 MHz.

EE 34 771 *pour plus amples renseignements*

MICROCELL ELECTRONICS LTD

Blackwater, Camberley, Surrey

ALIMENTATION À TRANSISTORS

Le bloc d'alimentation type 410 est un appareil d'établi fournissant une tension de sortie à variation continue de 1 à 30 V avec un courant de sortie de 5 A. Les niveaux de tension sont réglables par un transformateur à rapport variable assurant une sûreté de fonctionnement et un pouvoir de répétition élevés. La tension et le courant de sortie sont contrôlés par un appareil de mesure incorporé, et un disjoncteur à action rapide protège l'alimentation et le circuit extérieur contre toute surintensité. Le régime est continu jusqu'à 35°C.

Le bloc est fixé sur un panneau frontal de 48 cm. Il est normalement logé dans un boîtier Microcell mais il peut être monté sur bâti.

La résistance de sortie est inférieure à 0,01Ω et l'impédance alternative est inférieure à 0,3Ω jusqu'à 10 kHz. Le rapport de stabilité est de 500 : 1 pour une variation de puissance d'entrée secteur de 7,5%.

EE 34 772 *pour plus amples renseignements*

ALIMENTATION T.H.T. STABILISÉE

Le bloc type 411 est un ensemble d'alimentation très haute tension de service continu donnant une sortie de puissance à variation continue de 500 V à 3 kV, à 10 mA.

Fixé sur un panneau frontal de 48 cm il peut aussi être monté sur bâti quoiqu'il

soit normalement livré dans le nouveau boîtier Microcell.

Une attention toute particulière a été portée aux précautions de sécurité dans ce bloc qui est d'un emploi extrêmement sûr.

L'ondulation est d'environ 17 m de crête à crête à pleine charge et le rapport de stabilisation est de 2000 : 1 à 2 kV 5 mA. L'impédance de sortie est d'environ 100 ohms.

EE 34 773 *pour plus amples renseignements*

THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

CONDENSATEUR JUMELÉ

(Illustration à la page 394)

Le condensateur à blocs combinés type 28 a été étudié pour les récepteurs radio exigeant un dispositif d'accord d'une grande efficacité.

Le cadre de type rigide assure l'absence d'amorçages acoustiques basse-fréquence, et l'assemblage de rotor rigide et les palettes très espacées dans la partie oscillatrice suppriment la sensibilité à l'effet Larsen. Les vibrations de capacité sont suffisantes pour toutes les gammes d'ondes et conviennent parfaitement à la bande complète d'ondes courbes sans réglage d'appoint. Un degré très élevé de précision d'adaptation capacitive entre les deux parties permet à l'ingénieur de récepteurs de réaliser des circuits accordés avec une perte négligeable que pourrait provoquer toute désadaptation entre les sections oscillatrice et haute-fréquence. Un mécanisme de transmission de mouvement intérieur peut être fixé au condensateur, les rapports standard étant de 3 à 1, 6 à 1 et 8 à 1.

EE 34 774 *pour plus amples renseignements*

BOBINES D'EXPLORATION DE 110°

(Illustration à la page 394)

Cette série de bobinages d'exploration a été étudiée pour les tubes de télévision de 110°, de 43,1 cm à 58,4 cm. Les bobinages sont enroulés sur un moulage de polypropylène et peuvent être utilisés à toutes les températures susceptibles de se produire dans un service de télérécepteurs. Des calibres de forme spéciale sont utilisés pour bobiner les bobinages afin d'assurer une trame sans distorsion et une bonne concentration générale. Le couplage minimum entre bobines de ligne et bobines d'images permet de tirer parti au maximum des avantages qu'offrent les tendances modernes vers des circuits simplifiés de base de temps d'images.

Les bobinages sont livrables avec enroulements à haute ou à basse impédance et un choix est offert d'aimants fixes ou réglables pour la commande d'images.

Un nouveau bloc de cadrage a été imaginé, qui utilise une matière plastique armée de ferrite pour supprimer les pertes de puissance qui se vérifient dans les dispositifs de cadrage conventionnels. Un avantage supplémentaire de cet aimant de commande en matière plastique réside dans le fait qu'il retient son aimentation de façon permanente et ne se désaimante pas par le champ de bobinage d'exploration.

EE 34 775 *pour plus amples renseignements*

HAUT-PARLEUR MINIATURE

(Illustration à la page 394)

Ce haut-parleur de 3,17 cm de diamètre a été conçu pour être utilisé dans les récepteurs radio transistorisés miniature.

Le circuit magnétique met en œuvre une nouvelle technique de fabrication permettant de réduire au minimum la profondeur hors-tout, et qui consiste à insérer une barre-aimant dans un anneau d'aluminium fendu, qui est fixé sur une culasse usinée avec précision. La forme de construction donne un moteur compact sans nécessite d'employer des boulons d'assemblage magnétiques.

Le haut-parleur de 3,17 cm de diamètre est fourni avec une bobine mobile à impédance réduite (8 à 10Ω) pour pouvoir être utilisé dans un transformateur d'adaptation ou bien avec des bobines à impédance élevée pour jonction directe à des circuits à transistors.

EE 34 776 *pour plus amples renseignements*

STABILITY CAPACITORS LTD

Commerce Estate, Raven Road, London, E.18

CONDENSATEURS AU POLYESTER

(Illustration à la page 394)

Ces condensateurs ont été réalisés en fonction de la tendance vers les composants miniature et ils conviennent aux récepteurs radio transistorisés ainsi qu'aux applications générales.

La gamme de capacités prévues s'étend de 0,01 pF à 0,1 pF pour un fonctionnement à 125 V c.c.

On a répondu jusqu'ici à la demande pour cette gamme de valeurs de capacités soit par des condensateurs au papier et à feuilles soit par des condensateurs au papier métallisé. Le condensateur au polyester offre de multiples avantages par rapport à ces deux types, étant plus petit que celui au papier et à feuilles et plus économique que celui au papier métallisé. De plus la feuille de polyester est insensible à l'humidité et elle est stable jusqu'aux températures les plus élevées. Le mode de construction de ce condensateur donne une très faible autoinduction.

Ces propriétés, alliées à la protection qu'assure un revêtement en ciment dur, ont eu pour résultat un condensateur à bon marché qui répond à la plupart des conditions d'utilisation.

Les condensateurs au polyester sont livrables avec câbles axiaux ou dans un modèle nouveau de forme compacte avec cosses à fiches (brevet en cours d'octroi) pour circuits imprimés.

EE 34 777 *pour plus amples renseignements*

STRATTON & CO. LTD

Eddystone Works, Alvechurch Road, Birmingham 31

RÉCEPTEUR UHF

(Illustration à la page 395)

Le récepteur 770S est un nouveau modèle de récepteur à double changement de fréquence couvrant la gamme de fréquences de 500 Hz à 1000 MHz. L'étalonnage est précis à 1% près et l'étalon piézoélectrique fournit des repères de 10 MHz qui permettent le réglage de fréquence à 0,01% près. L'accord d'étalement de bande de ±10 MHz est assuré en accordant le second changeur de fréquence. Une entrée coaxiale de 500 ohms est prévue et la sensibilité est de l'ordre de 10μV.

Le récepteur emploie une première fréquence moyenne de 160 MHz avec une largeur de bande de 20 MHz et une seconde moyenne fréquence de 46,5 MHz. La largeur de bande totale est de 3 MHz. Le récepteur 770S est muni, enfin, d'un appareil de mesure d'accord et d'intensité de signal.

EE 34 778 *pour plus amples renseignements*

RÉCEPTEUR BASSE FRÉQUENCE

(Illustration à la page 395)

Le récepteur basse fréquence type S 850/2 a été conçu pour couvrir une plage de fréquences de 10 kHz à 600 kHz en six gammes de recouvrement. Une sélectivité variable, des filtres piézoélectriques et un filtre BF permettent d'obtenir un degré élevé de discrimination entre les signaux reçus. Des tensions d'entrée d'antenne de 75 et de 300 ohms, équilibrées et déséquilibrées, sont fournies et un circuit de contrôle automatique de gain maintient le niveau de sortie constant à 10 dB près pour un changement d'entrée de 80 dB au-dessus de 10 μV.

La réponse basse-fréquence est plate à 6 dB près entre 100 Hz et 6 kHz et la sortie maximum dans une impédance de 2·5Ω est d'environ 1 W. La sortie en phonie permet d'employer de façon satisfaisante des écouteurs à haute ou à basse impédance. Une sortie de puissance de 600 ohms peut être appliquée à l'usage équilibré ou déséquilibré.

La sensibilité est supérieure à 5 μV pour un rapport signal/bruit de 15 dB jusqu'à 100 kHz (30% de modulation de signal à 400 Hz) et elle est supérieure à 15 μV pour un rapport signal/bruit de 15 dB à des fréquences inférieures à 100 kHz.

EE 34 779 *pour plus amples renseignements*

SUFLEX LTD

54 Uxbridge Road, London, W.5

CONDENSATEURS RÉGLABLES AU POLYSTYRÈNE

(Illustration à la page 395)

Ces condensateurs ont été créés pour répondre aux besoins du réalisateur exigeant un condensateur au polystyrène réglable dans une gamme réduite.

Le condensateur est logé dans un boîtier hermétique de 5 cm × 5 cm × 2,8 cm avec une gamme de 0,45 pF à variation continue jusqu'à 0,5 pF. Le réglage se fait par écrou à six pans et la précision est à 0,1% près. D'autres valeurs, avec une variation de capacité de 10%, peuvent aussi être obtenues.

EE 34 780 *pour plus amples renseignements*

THERMIONIC PRODUCTS (ELECTRONICS) LTD

Hythe, Southampton, Hampshire

PONT DE BANDE MAGNÉTIQUE À HUIT VITESSSES

(Illustration à la page 395)

Ce pont de bande magnétique à huit vitesses est prévu pour les applications numériques et il a été étudié pour assurer toutes les vitesses lentes et moyennes de l'enregistrement sur bande magnétique. Les changements de vitesse et les fonctions de pont sont sélectionnées par bouton-poussoir. La construction judicieuse de l'enclenchement électrique élimine complètement la possibilité d'endommagement de la bande ou du mécanisme.

Le pont est muni d'un indicateur de longueur de précision, entraîné par la bande et pouvant lire jusqu'à 10 000 pieds de longueur et fournir une indication précise de l'endroit voulu.

Le dispositif de montage et de guidage des têtes a été conçu de la manière la plus souple. On peut ainsi monter jusqu'à quatre têtes. Si des tabliers azimutaux réglables sont exigés, le nombre maximum de têtes pouvant être fourni est de deux.

Le guidage de bande classique est normalement prévu mais si une grande densité de remplissage est nécessaire, on peut prévoir le guidage à un seul bord.

Le pont peut recevoir des largeurs de bande de 1,27 cm, 1,905 cm et 2,54 cm et des vitesses allant de 0,317 à 38,1 cm/sec peuvent être obtenues.

EE 34 781 *pour plus amples renseignements*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

ÉQUIPEMENT DE MESURE DE TEMPS ET DE FRÉQUENCES

(Illustration à la page 395)

L'équipement TSA 3336 est un nouveau matériel de mesure de temps et de fréquence alliant une spécification étendue avec un nouvel affichage en série du type à projection.

Il comprend des modules de circuits à fiches transistorisés, de la gamme Venner, et peut être fourni pour recevoir le dispositif imprimeur numérique transistorisé Venner type TSA 65 et pour l'enregistrement par bande perforée en utilisant le bloc reperforateur transistorisé Venner type TSA 101. Il peut aussi être fourni comme élément incorporé à un système complet de concentration de données. Le TSA 3336 peut effectuer des mesures de fréquences (phénomènes par unité de temps) jusqu'à 1 MHz, des inversions de fréquences (périodes), le comptage simple et les intervalles de temps en microsecondes ou en unités plus grandes. En outre, les sorties de l'oscillateur piézoélectrique de 1 MHz commandé par four et la chaîne de division numérique peuvent être affectées à l'usage extérieur sous forme d'impulsions de sortie "à mouvement d'horlogerie". L'instrument peut être réenclenché à distance ou par bouton-poussoir monté sur panneau ou bien encore par chronoscope de temporisation automatique.

L'oscillateur piloté au quartz de 1 MHz actionne sept étages diviseurs de décades. Six autres étages diviseurs de décades sont employés dans une chaîne de comptage. Des éléments binaires à réaction sont exclusivement utilisés dans l'appareil qui est aussi muni d'éléments de déclenchement, de mise en forme et de réenclenchement de la série Venner.

Le TSA 3336 comprend un indicateur en série à six chiffres avec insertion automatique du point décimal. De plus, un septième indicateur affiche les unités employées, par exemple les kHz, microsecondes, etc. Des indicateurs à échelle mobile d'un nouveau dessin breveté sont utilisés. Ces derniers donnent une lecture claire et sans ambiguité qui peut être lue à une distance considérable et ils ne sont pas exagérément directionnels. Un voyant rouge fixé près de la lecture indique que le thermostat commandé par four est en fonctionnement. Des boutons-poussoirs extrêmement légers, actionnant des microrupteurs sont utilisés dans les positions de "Réenclenchement 0", "Réenclenchement 9", "Arrêt" et "Marche".

EE 34 782 *pour plus amples renseignements*

Résumés des Principaux Articles

La "Sentinelle de signal"- un système de contrôle et d'alarme constitué de corps solides par M. L. Klein et J. P. Hart

Résumé de l'article aux pages 344 à 348

Le controle des procédés de fabrication, les travaux médicaux et le contrôle de la qualité exigent un dispositif d'alarme et de contrôle de précision constitué de corps solides. A cet égard, le "Signal Sentry" fournit une précision de contrôle de 0,1% sur niveaux de courant continu à entrées multiples. Il assure, en outre, son propre contrôle intérieur sur 12 tensions critiques. Il se compose d'un élément multiplexeur, d'un voltmètre numérique entièrement transistorisé et il utilise la programmation et la logique par cartes perforées. Toutes les données qui s'accordent avec le programme sont rejetées. Les données hors programme déclenclent l'alarme. Trente canaux peuvent être balayés en moins de 300 millisecondes, permettant ainsi l'utilisation de l'instrument pour le contrôle critique de procédés.

L'étude de condensateurs à impédance réduite destinés, en particulier, aux filtres par C. W. McCutchen et I. D. Howard

Résumé de l'article aux pages 349 à 353

Cet article examine les méthodes tendant à réduire l'inductance en série des condensateurs conventionnels. Les propriétés de la partie effectivement capacitive de ces condensateurs sont étudiées en vue de la mise au point d'une méthode de raccordement pour condensateurs de filtrage permettant aux pertes capacitives d'aider le filtrage.

Caractéristiques et applications des tubes à décharge par F. A. Benson

Résumé de l'article aux pages 354 à 359

Cet article passe en revue les travaux effectués récemment en vue de déterminer les caractéristiques et les limites des tubes à décharge. Il étudie d'abord l'effet d'une variation de la teneur en argon des tubes de référence au néon/argon, l'utilisation du krypton et du xénon comme produits d'addition et les caractéristiques des mélanges gazeux hélium/néon et de hélium/argon. Il examine ensuite les propriétés des cathodes monocristallines, polycristallines et activées. Les sections suivantes traitent des variations de pression gazeuse, du coefficient de température de la tension de fonctionnement du bruit, des métal-céramique, des caractéristiques d'impédance et des tubes à cathodes creuses, de la pulvérisation, des effets photoélectriques, du rétablissement gazeux et de diverses autres caractéristiques. Il mentionne, enfin, quelques applications de ces tubes.

Le transistor en tant qu'élément sensible à la température dans les dispositifs de contrôle thermique par J. E. Pallett

Résumé de l'article aux pages 360 à 363

Cet exposé traite en détail de la méthode par laquelle un transistor est utilisé dans le circuit à base commune pour détecter les changements de température dans un dispositif de contrôle thermique. On y montre que ses principaux avantages par rapport aux autres méthodes sont une sensibilité élevée, pouvant aller jusqu'à IV/°C, mais qui est, évidemment, limitée aux températures de l'ordre de 90°C pour les transistors au germanium ou de 150°C pour les transistors au silicium.

La production d'impulsions dans l'Analyseur différentiel numérique Corsair par P. L. Owen, M. F. Partridge et T. R. H Sizer

Résumé de l'article aux pages 364 à 371

Cet article, qui est le premier d'une série de quatre articles décrivant les détails de montage et de réalisation de l'analyseur différentiel numérique transistorisé CORSAIR, traite de la production des impulsions de commande. Quoique la théorie de la production ne soit, au fond, qu'une théorie de division d'impulsions, les processus par lesquels cette division s'effectue sont peu courants, particulièrement dans le cas des processus alliés à la logique parallèle de la machine.

Numération Booléenne pour l'entretien des circuits de commutation par S. Alexander

Résumé de l'article aux pages 372 à 374

L'auteur propose une méthode pour la numération des circuits de commutation, en soulignant particulièrement son application à l'établissement de programmes d'essais et d'entretien. Cette méthode est basée sur l'algèbre booléenne qui est déjà d'un usage très répandu pour la réalisation de circuits de commutation. Plusieurs exemples sont donnés, y compris un modèle de programme d'essais.

Une nouvelle méthode rapide pour le calcul des circuits amplificateurs à transistors par R. R. Vierhout et A. J. H. Vendrik

Résumé de l'article aux pages 375 à 381

Si l'on ne tient pas compte du paramètre hybride h12, comme on peut le faire pour les calculs pratiques, le transistor peut être considéré comme un amplificateur de courant de la même façon qu'on considère une lampe comme un amplificateur de tension. Une valeur utile est représentée par l'impédance de transfert, au moyen de laquelle on peut calculer facilement de nombreuses caractéristiques des circuits à reaction. On démontre dans cet article qu'une impédance d'entrée de plusieurs mégohms peut être obtenue avec un type spécial de réaction.

Diverses manières d'améliorer la stabilité thermique des circuits à transistors sont examinées dans la deuxième partie, à l'aide d'une méthode simple de calcul. Des formules se rapportant au facteur de bruit dans les circuits à transistors sont également étudiées.

Un analyseur de fonctions de propagation pour composantes linéaires et non-linéaires par A. K. Choudhury, M. S. Basu et A. K. Mahalanabis

Résumé de l'article aux pages 382 à 385

Cet article décrit une méthode pour mesurer l'amplification et la phase de la réponse de fréquence de composantes physiques linéaires et non-linéaires. Cette méthode n'exige que des résistances et des condensateurs ordinaires, ainsi que les autres accessoires communément utilisés dans tout laboratoire d'électronique, et elle assure un degré élevé de précision dans une gamme étendue de fréquences, à partir de valeurs extrêmement basses. L'article présente également des résultats de mesures de quelques caractéristiques non-linéaires.

Ausstellung für ELEKTRONISCHE BAUELEMENTE

Beschreibung einer Auswahl der auf der Ausstellung des Verbandes der Hersteller von Radio- und elektronischen Bauelementen in den Olympia-Hallen, London, vom 30. Mai bis 2. Juni gezeigten Bauelemente nach Angaben der Hersteller. *Übersetzung der Seiten 390 bis 395*

AIRCRAFT-MARINE PRODUCTS (GREAT BRITAIN) LTD

Ample House, 87-89 Saffron Hill, London, E.C.1

MEHRLOCH-FERRITKERN

(Abbildung Seite 390)

Ein AMP-MAD-Mehrlochelement benutzt besonders gestaltete Magnetkerne aus Ferritwerkstoff mit rechteckiger Hystereseschleife, in denen eine Anzahl kleiner Löcher um ein Hauptloch angeordnet sind.

Diese Elemente können Digital- und Analogdaten speichern. Sie haben die einzigartige Eigenschaft, infolge der korrekten geometrischen Anordnung der kleinen Löcher um das Hauptloch inherent störungsfreies Auslesen gespeicherter Daten zu ermöglichen.

Die Wirkungsweise kann kurz wie folgt beschrieben werden: Flussschalten beginnt am inneren Durchmesser (oder kürzesten Kraftlinienweg) eines Ringkernes und schreitet zum äusseren Durchmesser (dem längsten Kraftlinienweg) fort, bis das Flussfeld völlig umgekehrt ist. Die Schaltschwelle kann bei einem gegebenen Werkstoff durch Herabsetzung des inneren Kerndurchmessers herabgesetzt und durch Vergrösserung des inneren Durchmessers heraufgesetzt werden. Sättigungssteuerung kann durch Anwendung derselben Regeln auf den Aussendurchmesser beeinflusst werden. Durch genaue Kontrolle des Ferritwerkstoffes kann zwischen Steuerung und Remanenzfluss eine geradlinige Beziehung erreicht werden, und die Schwelle des kleineren Loches ist bedeutend kleiner als die des Hauptloches, da der Weg kürzer ist.

Ungleich herkömmlichen Ringkernen wird der MAD-Kern durch Umkehr der Hälfte des gesamten Remanenzflusses "eingestellt". Durch Anlegen der vollen Schaltsteuerung an einen vorher gelöschten Kern wird der Remanenzfluss am Hauptloch bis zu einem Punkt halbwegs zwischen dem inneren und äusseren Kerndurchmesser umgekehrt. Jetzt besteht ein linksläufiger Remanenzfluss im inneren und ein rechtsläufiger im äusseren Kernteil. Das inherent zerstörungsfreie Auslesen ist eine Charakteristik der kleineren Löcher eines MAD-Kernes im "eingestellten" Zustand. Wenn ein kleineres Loch mit einer Primär- (Steuerungs-) Wicklung und einer Sekundär- (Auslese-) Wicklung ausgerüstet ist, kann der Ausgangswicklung, die mit ihrer Primärwicklung durch den äusseren Kraftlinienweg des kleinen Loches gekoppelt ist, eine kontinuierliche, zerstörungsfreie Auslese entnommen werden. Im "eingestellten" Zustand schaltet die an die Primärwicklung des kleineren Loches gelegte Treibspannung örtlich den Fluss um das kleinere Loch um und wird auf einen Wert eingeregelt, der unter dem Schwellenniveau des Hauptloches liegt. Im "gelöschten" Zustand und mit geregelter Treibspannung für das kleinere Loch kann der Remanenzfluss nicht um das kleinere Loch herum geschaltet werden, und daher kann keine Auslese erfolgen. Um das kleinere Loch herum geschalteter Fluss kann den "eingestellten" Zustand des Kernes nicht aufheben.

EE 34 751 *für weitere Einzelheiten*

ANTIFERENCE LTD

Bicester Road, Aylesbury, Buckinghamshire

DACHBODENANTENNE

Eine neue Dachbodenantenne Type HL514 für alle Kanalkombinationen für Band I/III mit vertikaler Polarisation ist lieferbar. In das doppeltgetriebene Antennengebilde ist ein teleskopischer Einzeldipol für Band I und Band III-Elemente eingebaut. Die Antenne wird komplett mit Winkelarm und Halterung geliefert.

EE 34 752 *für weitere Einzelheiten*

AUSGLEICHER

Dieser neue Baustein ist ein "frequenzbewusster Abschwächer", der für einfachen Einbau in die Abführung ausgelegt ist. Er gibt veränderliche Dämpfung des Band I-Signals ohne Band III zu beeinflussen, oder von Band III-Signalen ohne Beeinflussung von Band I. Dadurch ergibt sich ohne Schwierigkeit ein ausgeglichenes Signal in Gegenden, für die die Sender nicht zusammenliegen, unterschiedliche Leistung haben, oder wo durch schlechte Empfangsbedingungen ein ungleiches Signal empfangen wird.

EE 34 753 *für weitere Einzelheiten*

ASHBURTON RESISTANCE CO. LTD

72 Brewery Road, London, N.7

WIDERSTÄNDE FÜR GEDRUCKTE SCHALTUNGEN

Diese Präzisionswiderstände wurden besonders für gedruckte Schaltungen entwickelt. Der als ERP1 bezeichnete Widerstand wurde eingeführt, um das Brechen von Anschlussdrähten zu vermeiden, das beim Einbau von Widerständen in gedruckte Schaltungen oft auftritt. Zu den Konstruktionsmerkmalen gehören daher 0,8 mm dicke, radiale Anschlussdrähte aus verzinntem Kupfer.

Der ERP1 hat eine Nennlast von 1/10 W und ist für 2,54 mm Rastersysteme bestimmt; der Abstand zwischen den Anschlusspunkten ist 10,1 mm. Toleranzen rot, grün, gelb und blau (±1, 0,5, 0,25 und 0,1) sind lieferbar.

Der neuerdings von Ashburton zur schnellen und genauen Feststellung von Toleranzen eingeführte Farbcode wird für alle Arcol Präzisions-Widerstände benutzt.

Der ERP1 wird z.Z. mit Epoxyharz verkapselt.

EE 34 754 *für weitere Einzelheiten*

HOCHBELASTBARE WIDERSTÄNDE

(Abbildung Seite 390)

Das Ashburton Programm wurde durch Einführung von hochbelastbaren Widerständen von 200 ... 750 W erweitert. Die Schutzhauben für die Widerstände bestehen aus Stahlblech mit Luftschlitzen oder Löchern und sind mit verschiedenen Oberflächenbehandlungen lieferbar.

Die Hauben decken die stromführenden Teile der Widerstände ab, so dass sie ohne Gefahr ausserhalb des Gerätes angebaut werden können; die Anschlussklemmleisten bleiben jedoch leicht zugänglich.

Zwei Haubentypen mit Luftschlitzen sind lieferbar—eine mit vertikalen und eine mit horizontalen Schlitzen. Auf diese Weise kann ein hochbelastbarer Widerstand in einem Gerät entweder vertikal oder horizontal eingebaut werden, wobei die Wicklung immer gegen Kondensationstropfen geschützt ist.

EE 34 755 *für weitere Einzelheiten*

BADER MACHINERY CO. LTD

Hersham Factory Estate, Walton-on-Thames, Surrey

Diese Firma stellt eine grosse Auswahl schneller automatischer Anlagen für die Fertigung von Halbleitern, Glühlampen, Radioröhren und Elektronenstrahlröhren her. Folgende Maschinen sind typische Beispiele:

16KÖPFIGE DIODEN-DOPPELPERLUNGS-MASCHINE

Die Maschine ist mit einem geschlossenen Getriebekasten ausgerüstet, dessen gehärtete und geschliffene Stahlkegelrollen in einen dreidimensionalen fassförmigen Schaltnocken eingreifen, der für konstante Beschleunigung und Verlangsamung ausgelegt ist. In der Beheizungsposition rotieren die Verschmelzungsköpfe und werden durch einen getrennten Regelmotor gesteuert. Alle Hauptlager der Maschine werden von einer zentralen Stelle automatisch geschmiert, und alle Zulaufvorrichtungen und andere mit den Einzelteilen in Berührung kommende Teile sind spiegelblank und mit Plexiglas abgedeckt, um die im Zulauf befindlichen Einzelteile gegen Eindringen von Staub usw. zu schützen. Die höchste Schaltgeschwindigkeit ist 2000 pro Stunde, d.h. der höchste Ausstoss ist 4000 Teilmontagen pro Stunde. Der Arbeitsgang ist wie folgt:

(a) Automatische Zufuhr der Elektroden entweder von einer Rolle oder einer Zulaufvorrichtung mit vorgeschnittenen Elektroden. Wenn die Elektroden von einer Rolle zugeführt werden, wird eine Richtvorrichtung und ein Schneider eingebaut, um genaue Einzelteile zu gewährleisten.

(b) Automatisches Füllen der vorgeschnittenen Glasperlen aus einem Trichter.

(c) Die Perlen werden mittels Gasbrennern an die Elektroden angeschmolzen, und während dieses Vorganges rotieren die Köpfe schnell, so dass eine konzentrische Verschmelzung stattfindet.

(d) Die komplette Teilmontage wird automatisch in Magazine mit 50 Positionen ausgeladen. Die Magazine werden von Hand eingebracht und automatisch durch die Ausladeposition geschaltet.

(e) Wenn keine Teile im Kopf sind, schaltet das Magazin nicht, wodurch erreicht wird, dass alle die Maschine verlassenden Magazine voll sind.

(f) Der Entladungsposition folgt eine Säuberungsposition, in der der Kopf mit einem Hochdruckluftstrahl ausgeblasen wird, bevor er neue Einzelteile aufnimmt.

(g) Der Magazinzubringerweg kann drei Magazine aufnehmen, und all 1½ Minuten verlässt ein volles Magazin die Entladungsposition.

EE 34 756 *für weitere Einzelheiten*

DIODENLEGIERUNGSÖFEN

Eine horizontale Tunneltype und ein vertikaler Ofen sind Standardausführungen; jede Type hat besondere Vorteile.

Im Legierungsofen werden mit Teilmontagen gefüllte Magazine in zwei elektrisch geheizte Zonen befördert—eine Vorwärm- und eine Hochtemperaturzone, deren Temperatur von 200° ... 800°C regelbar ist. Gaseinlass ist vorgesehen, so dass Edelgas als Schutzatmosphäre zugeführt werden kann. Während des Lötvorganges wird die Lötmittelperle geschmolzen, und das Gewicht drückt auf die Scheibe, so dass eine gute Verbindung hergestellt wird. Eine automatische Temperaturregelung hält die Temperatur im Ofen innerhalb 5% der Skaleneinstellung.

Nach dem Legieren werden die Magazine in eine Kühlzone befördert, wo die Temperatur auf ungefähr 20°C absinkt. Das ist eine Pufferposition, die die zur Abkühlung der Magazine erforderliche Zeitspanne zulässt. Nach dem Abkühlen entfernt der Arbeiter die Magazine für den nächsten Arbeitsgang, wobei er die Gewichte herausfallen lässt, so dass sie für weitere Verwendung zur Verfügung stehen.

EE 34 757 *für weitere Einzelheiten*

BIRMINGHAM SOUND REPRODUCERS LTD

Monarch Works, Old Hill, Staffordshire

PLATTENSPIELER

(Abbildung Seite 391)

Modell GU6 ist ein kompakter Plattenspieler für 16, 33⅓, 45 und 78 UPM. Es hat einen automatischen Stop am Ende jeder Platte, und die Gummi-Übertragungsrolle wird automatisch aus dem Eingriff gebracht, wenn das Gerät ausgeschaltet wird. Der Plattenspieler ist zur Verminderung der Gehäuseresonanz federnd gelagert, und es wird angegeben, dass Geschwindigkeitsschwankungen und Rumpeln praktisch nicht auftreten. Der Tonarm kann mit jedem Abtastkopf der BSR-"Ful-Fi"-Serie ausgerüstet werden.

EE 34 758 *für weitere Einzelheiten*

DAWE INSTRUMENTS LTD

99-101 Uxbridge Road, Ealing, London, W.5

TRANSISTORISIERTER PHASENMESSER

(Abbildung Seite 391)

Der Phasenmesser Type 630 ist ein volltransistorisiertes, netz- oder batteriebetriebenes Gerät, das die Phasendifferenz zwischen zwei Signalquellen misst. Zwei Begrenzungsverstärker werden mit Signal- bzw. Bezugseingangsspannung gespeist. Die sich ergebenden Ausgangsspannungen werden differenziert und in positive Impulse umgewandelt, die in demselben Phasenverhältnis stehen wie die Eingangssignale. Die Impulse des einen Verstärkers schalten eine bistabile Schaltung "ein", die des anderen Verstärkers schalten sie "aus". Das Impulsbreitenverhältnis der entstehenden Rechteckwellenform ist der Phasendifferenz zwischen den Eingangsquellen proportional und wird direkt auf einem Drehspulinstrument angezeigt.

Der Frequenzbereich ist 1 Hz ... 25 kHz und die Phasenwinkelbereiche 0° ... 360° und 180°-0-180°. Für symmetrische Signale ist die Genauigkeit ±3°.

EE 34 759 *für weitere Einzelheiten*

TRANSISTORISIERTER SCHWINGUNGS-MESSER

(Abbildung Seite 391)

Der Transistor-Schwingungsmesser Type 1431 besteht aus einem Schwingungsgeber, einem Hochleistungsverstärker mit integrierenden und differenzierenden Netzwerken und einem regelbaren Abschwächer, sowie einem direkt anzeigenden Messgerät. Das tragbare Transistorgerät ist zum Messen der drei wichtigsten Schwingungskennwerte ausgelegt: Weg, Geschwindigkeit und Beschleunigung. Das Gerät ist in Forschung, Entwicklung und Fertigung unschätzbar, wo der schädliche Einfluss von Verschleiss und geräuschvollem Betrieb vermieden werden muss.

Der mit dem Gerät gelieferte Schwingungsgeber Type 1403/1 ist von elektrodynamischer Konstruktion und gibt eine der Geschwindigkeit der zu untersuchenden Bewegung proportionale Spannung ab. Das Gerät kann mit Batterien oder Netzgerät betrieben werden.

Schwingungsbereiche:

Weg: Sieben Bereiche von 0 ... 0,0076 mm bis zu 0 ... 7,62 mm Null-zu-Spitze.

Geschwindigkeit: Neun Bereiche von 0 ... 0,076 mm/s bis zu 0 ... 76,2 cm/s Spitzenwert.

Beschleunigung: Fünf Bereiche von 0 ... 254 cm/s² bis zu 0 ... 254 m/s² Spitzenwert.

Frequenzbereich: 5 Hz ... 2 kHz.

Ein in metrischen Einheiten geeichtes Gerät ist als Type 1431B lieferbar.

EE 34 760 *für weitere Einzelheiten*

ELECTRONIC COMPONENTS LTD

Weedon Road, Industrial Estate, Northampton

VIERKANAL-MISCHPULT

(Abbildung Seite 392)

Das Gerät wurde entwickelt, um den Bedarf für eine kompakte Mehrkanal-Mischeinrichtung zu befriedigen, deren Qualität für Studiozwecke ausreicht und gleichzeitig in einer für den Amateur tragbaren Preislage liegt.

Die Schaltung ist eine Weiterentwicklung des elektronischen Elcon-Blenders und so zusammengestellt, dass Einfachheit und gute Qualität erhalten bleiben.

Vier getrennte hochohmige Eingänge speisen Vorverstärker mit 20 dB Verstärkungsgrad und vorgewählter Verstärkung sowie Tiefen- und Höhenregelung. Jeder Kanal wird mittels eines Quadrantentypblenders gesteuert, der es ermöglicht, über den Bereich 0 ... 60 dB getrennt ein- und auszublenden sowie abzuschalten. Über die Abschaltstellung hinausgehend hat jeder Kanal eine Monitoreinstellung, die es der Bedienung ermöglicht, einen gewählten Kanal abzuhören, während dieser Kanal vom Mischpult abgeschaltet ist. Wenn die entsprechende "Einsatzstelle" gehört wird, kann dann schnell und bequem eingeblendet werden. Diese Eigenschaft ist mit dem untenstehend beschriebenen Monitorausgang verbunden.

Die vier Kanäle werden im Mischpult

zusammengebracht und mittels eines Quadrantentyp-Summenreglers gesteuert, der wieder einen Bereich von 0 ... 60 dB und eine "Aus"-Position hat. Der endgültig gemischte und geregelte Ausgang steht normalerweise mit einer Impedanz von 600Ω zur Verfügung, jedoch können höhere Impedanzen für Sonderaufträge geliefert werden.

Als Monitor ist eine Spitzenpegelsichtanzeige vorgesehen, und ausserdem steht vom endgültig gemischten Signal über eine Klinke ein 5 kΩ-Ausgang zur gehörmässigen Bewertung zur Verfügung.

Die Kanal- und Summenregler sind mit Signallampen ausgerüstet, die ein grünes Licht zeigen, wenn der Kanal ausgeschaltet und ein rotes, wenn er eingeschaltet ist.

Der Gesamtklirrfaktor des Mischpultes liegt unter 0,25%. Der Geräuschabstand ist besser als 70 dB, und der Frequenzgang ist von 40 Hz bis über die Hörgrenze hinaus zufriedenstellend.

Ein wichtiges Konstruktionsmerkmal ist die Verwendung von Einschubbausteinen für die einzelnen Schaltungsteile und Reglereinheiten, so dass beim Auftreten von Fehlern der entsprechende Baustein schnell gefunden und ausgewechselt werden kann.

Eine Fremdstromquelle für 12 V Gleichstrom wird sowohl für die elektronische Schaltung als auch für die Signallampen benötigt. Beide Kreise werden getrennt zu einem Stecker herausgeführt, so dass bei Einsatz als tragbares Gerät nur für den elektronischen Teil eine Stromquelle geringer Leistung Verwendung finden kann.

EE 34 761 *für weitere Einzelheiten*

GARDNERS RADIO LTD

Somerford, Christchurch, Hampshire

TRENN- UND NIEDERSPANNUNGS-TRANSFORMATOREN

(Abbildung Seite 392)

Unter dem Namen "Castle" stellt Gardners eine neue Reihe von Spar-, Trenn- und Niederspannungstransformatoren her, um den mannigfachen Bedarf für Haushaltsgeräte, kleine Maschinen und Schwachstrombeleuchtung zu decken.

Zur Vereinfachung der Konstruktion wurde der Eingang auf 230 ... 240 V genormt, Transformatoren für andere Netzspannungen werden jedoch im Sonderauftrag angefertigt. Um den Schutzvorschriften zu genügen, haben die Typen mit zwei Wicklungen (CAS 900 ... CAS 916) eine Mittelanzapfung und sind mit elektrostatischer Abschirmung zwischen den Wicklungen ausgerüstet. Alle Transformatoren sind für Dauerbetrieb bemessen, und wo sie nur für unterbrochenen Betrieb, z.B. kurze Betriebszeiten mit gleichen Restperioden Verwendung finden, kann im allgemeinen die nächste niedrigere Nennbelastungstype gewählt werden. Jeder Transformator wird mit 1,50 m Verbindungsleitung für den Eingang und einem geeigneten Stecker für den Ausgang geliefert. Der Eingang ist durch eine leicht auswechselbare Schraubsicherung geschützt.

Die Transformatoren mit zwei Wicklungen sind für folgende Nennleistungen lieferbar: 12 V, 12 VA bis 110 V, 500 VA und 240 V, 200 VA. Die Sparausführungen haben Ausgangsleistungen von 25 VA bis 550 VA bei 115 V.

EE 34 762 *für weitere Einzelheiten*

GENERAL CONTROLS LTD

13-15 Bowlers Croft, Honywood Road, Basildon, Essex

WENDELPOTENTIOMETER

(Abbildung Seite 392)

Die Wendelpotentiometer-Typenreihen PK15 und PM15 sind 3- und 10gängige Miniatur-Präzisionsbauelemente. Die hervorstehende Eigenschaft ist die Präzision eines so kleinen Wendels mit einem Höchstwert von 120 kΩ für den 10gängigen und 40 kΩ für den 3gängigen Wendel. Es hat feste Endanschläge und kann mit Kugel- oder Gleitlager, für Buchsen- oder Servomontage geliefert werden. Die beste praktisch erreichbare Linearität bei Sonderauftrag ist ±1%. Der Durchmesser des Körpers ist 22,23 mm und die Gesamtlänge des 10gängigen Modells 37,67 mm.

Die Typenreihen PK30 und PM30 sind 3- und 10gängige Potentiometer mit einem Höchstwert von 150 kΩ für das 3gängige und 500 kΩ für das 10gängige Modell. Die Bauelemente haben feste Endanschläge und können mit Kugel- oder Gleitlagern ausgerüstet, sowie für Buchsen- oder Servomontage geliefert werden. Der Körperdurchmesser ist 46 mm und die Gesamtlänge des 10gängigen Modells 50,8 mm; die Gesamtlänge des 3gängigen Modells ist 31,2 mm. Für augewählte Werte ist die beste erreichbare Linearität 0,05%.

EE 34 763 *für weitere Einzelheiten*

DREHUNGSZÄHLER

(Abbildung Seite 392)

Der Drehungszähler hilft bei der Einstellung und Positionsanzeige von Präzisions-Drehbauelementen wie mehrgängigen Potentiometern und Drehkondensatoren. Die grosse, klare Digitalanzeige kann auf den ersten Blick abgelesen werden und gibt die genaue Position eines mehrgängigen Bauelementes an.

Konstantes Drehmoment erlaubt äusserst genaue Nachregelung mit Fingerspitzengefühl. Gleichförmiger Lauf aller beweglichen Teile mit geringem Spiel gewährleistet wahre und genaue Ablesung selbst der geringsten Änderung und Bewegung der Hauptspindel.

Die Zähler sind als Modelle mit dreistelliger Anzeige lieferbar und können Drehvorrichtungen bis zu einem Maximum von 10 Umdrehungen leicht angepasst werden. Die Anzeige erfolgt als Prozentsatz der Gesamtdrehung in vollen Umdrehungen, Zehnteln und Hundertsteln.

Sechs Modelle für 6,35 mm und 3,18 mm Spindeldurchmesser werden später produziert.

EE 34 764 *für weitere Einzelheiten*

SERVO-POTENTIOMETER

(Abbildung Seite 392)

Alle Teile dieses in USA entwickelten Präzisions-Potentiometers sind genau bearbeitet, Deckel und Boden mit Kugellaufbahnen ausgerüstet, um geringstes End- und Seitenspiel sowie ein niedriges Betriebsdrehmoment zu erzielen.

Der nutzbare Drehwinkel für die Standardausführung ist 300°, kann aber im Sonderauftrag auf 355° erhöht werden. Der Höchstwert ist 200 kΩ bei Wicklung auf Karten. Im Einzelfall kann die Linearität durch Auswahl bei 0,25% gehalten werden.

Der Aussendurchmesser ist 45 mm und die Tiefe 31 mm; die Nennbelastung für Wicklung auf Karten ist 4 W und auf Lewmex-Wickelkörper 2 W. Das Bauelement kann auch als Schleifdraht mit unendlicher Linearität bis zu 10Ω hergestellt werden. Zur Erhöhung der Genauigkeit und Konstanz werden die Wicklungsenden an die Fahnen angeschweisst. Bis zu 6 Potentiometer können in einen Satz zusammengebaut werden.

EE 34 765 *für weitere Einzelheiten*

THE GOLDRING MANUFACTURING CO. (GREAT BRITAIN) LTD

486-488 High Road, Leytonstone, London, E.11

EIN BATTERIEBETRIEBENER PLATTENSPIELER

(Abbildung Seite 393)

Der batteriebetriebene Plattenspieler hat vier Geschwindigkeiten, einen automatischen Stop und einen Sechspol-Gleichstrommotor mit geringem Stromverbrauch. Die Geschwindigkeit ist über den Spannungsbereich von 5 ... 9 V konstant. Der 20 cm-Plattenteller ist halb ausgespart und die Aussenabmessungen sind 22,8 × 28 cm. Das Gerät wird komplett mit Tonarm und Abtastkopf geliefert.

EE 34 766 *für weitere Einzelheiten*

HELLERMANN LTD

Crawley, Sussex

KABELBEZEICHNUNG AUF BINDEHÜLSEN

Die folgenden drei Kabelhülsen wurden entwickelt:

Helsyn 150

Diese neue Hülse wurde infolge der höheren Leistungsforderungen entwickelt. Helsyn 150 ersetzt Helsyn 100, da sie einen wesentlich höheren Widerstand gegen Flüssigkeiten, Ozon und Wärme hat.

Helsyn TX

Auf Grund ihres sehr hohen Ozonwiderstandes sollen die Helsyn TX—Hülsen und Markierer die bisherige Helsyntype ersetzen. Sie werden aus einem auf Neopren beruhenden Werkstoff im Strangpressverfahren hergestellt, enthalten keinen Gummi und entsprechen in jeder Beziehung den Bedingungen des Pflichtenblattes DEF 20.

Twintex

Twintex ist eine neue Hellermann-Hülsentype, die für hohe Temperaturen entwickelt wurde und deren Feuchtigkeitswiderstand dem der Helaprene-Hülsen überlegen ist.

EE 34 767 *für weitere Einzelheiten*

THE LEWIS SPRING CO. LTD

Resilient Works, Redditch, Worcestershire

TRANSISTORSCHELLEN

Die L.S. Transistorschellen-Baureihe ist aus Beryllium-Kupfer hergestellt und so ausgestaltet, dass sie die Wärmeabfuhr unterstützt. Sie ist für zylindrische Transistoren wie z.B. Mullard OC72, SB345 und OC170 geeignet und kann schnell und einfach auf Schaltplatten durch 4 mm Löcher horizontal befestigt werden.

EE 34 768 *für weitere Einzelheiten*

MARCONI INSTRUMENTS LTD

St. Albans, Hertfordshire

GROSSBEREICH-RC-OSZILLATOR

(Abbildung Seite 393)

Dieser Grossbereich-Wien-Brücken-Oszillator überstreicht 10 Hz ... 10 MHz (sinusförmig) in sechs Dekadenbändern. Das höchste Band ist ungewöhnlich breit mit konstanter Ausgangscharakteristik von 1 ... 10 MHz und ist für Frequenzgangtests in Video- und niedrigeren KW-Bändern geeignet. Für die vier niedrigen Bänder wird eine Skala benutzt; den beiden höchsten Bändern sind getrennte Skalen zugeordnet. Die sich ergebende Gesamtskalenlänge von 266,7 cm ermöglicht Ablesung von 1%igen Änderungen der Frequenz. Schnelle und genaue Abstimmung sind durch Doppelübersetzung des Antriebs gewährleistet, wobei die Grobabstimmung ein Verhältnis von 3 : 1 und die Feinabstimmung ein Verhältnis von 18 : 1 hat.

Über einen umschaltbaren Abschwächer mit einem Bereich von 60 dB in 10 dB—Stufen stehen Ausgangsspannungen von 1 mV bis 3,16 V zur Verfügung. Der an den Abschwächer angelegte Eingangssignalpegel ist kontinuierlich regelbar und wird mittels eines Instrumentes überwacht, das in Leerlaufspannung und dB geeicht ist. Der Ausgangswiderstand kann auf 75, 100 oder 600 Ω eingestellt werden. Als wahlweiser Zubehör ist ein 100faches Abschwächernetzwerk lieferbar, über das niedrige Ausgangsspannungen bis zu 10 μV herunter bei 75 oder 5Ω entnommen werden können. Für Frequenzen unter 100 kHz stehen Spannungen bis zu 31,6 V an anderen Klemmen zur Verfügung.

Das Gerät ist für Einsatz mit Übertragungsleitungen, Filtern, Abschwächern usw. sehr geeignet. Unter den weiteren Verwendungszwecken ist Benutzung als Sinuswellengenerator für die Erregerspannung von Ton- und Hochfrequenzbrücken zu erwähnen.

Der TF 1370 kann auch eine Präzisions-Rechteckwellenform mit Spitzenspannungen bis zu 31,6 V und Frequenzen zwischen 10 Hz und 100 kHz abgeben.

EE 34 769 *für weitere Einzelheiten*

BREITBAND-MILLIVOLTMETER

(Abbildung Seite 393)

Ein grosser Frequenzbereich (30 Hz ... 30 MHz) in Verbindung mit Stabilität, Genauigkeit und Empfindlichkeit gibt diesem Voltmeter weite Verwendungsmöglichkeiten. Der Spannungsbereich von 100 μV ... 300 mV kann mit einem wahlweise lieferbaren Vorschaltsatz auf 30 V erhöht werden.

Das TF 1371 kann kleine Wechselspannungen von Netzfrequenzen bis zur unteren Grenze der UKW-Frequenzen messen; es kann an HF-, ZF-, Video- und Tonfrequenzverstärkern benutzt werden und ermöglicht Messung aller Signalpegel in KW-Empfängern von der Antenne bis zum Lautsprecher.

Das 140 mm—Anzeigeinstrument spricht auf die durchschnittlichen Werte einer Wechselspannungs-Wellenform an und ist in Effektivwerten einer Sinuswellenform geeicht; es hat zwei Millivoltskalen und eine Skala in Dezibel auf 1 mW an 600 Ω bezogen. Um die Genauigkeit langzeitig aufrecht zu erhalten, kann die Eichung mit einer internen Quelle verglichen werden.

EE 34 770 *für weitere Einzelheiten*

PRÄZISIONS-QUARZEICHER

(Abbildung Seite 393)

Der TF 1374 überstreicht den Frequenzbereich von 100 kHz ... 1,5 GHz mit einer Konstanz von 1×10^{-6} pro Monat und gibt Quarzkontrollpunkte in Form eines Schwebungsnulls im Kopfhörer. Die Punkte treten in durch Schalter wählbaren Abständen von 10 MHz, 2 MHz, 500 kHz oder 10 kHz auf. Jede Punktreihe steht getrennt zur Verfügung und ist vollkommen frei von subharmonischen Schwingungen. Die 100 kHz—Punkte sind bis mindestens 500 MHz klar und deutlich, und die 10 kHz Punkte können bis zu 10 MHz benutzt werden. Jede der Kontrollfrequenzen steht an Ausgangsklemmen zur Verfügung.

Genauigkeit, einfache Bedienung und deutlich feststellbare Kontrollpunkte ohne störende Zwischenschwingungen geben dem Gerät ideale Eigenschaften für Verwendungszwecke wie Eichung von Signalgebern und Oszillatoren oder Einstellung von KW-, UKW- und UHf-Senderfrequenzen. Die Standardfrequenz-Ausgangsspannung kann zur Eichung von Empfängern und Wellenmessern benutzt werden; der nutzbare Frequenzbereich für Empfängertests hängt von der Empfindlichkeit, Spiegel- und Zwischenfrequenzdurchbruch ab, jedoch kann das Gerät für durchschnittliche Empfänger bis zu mindestens 100 MHz benutzt werden.

Wahlweise steht auch Ausführung TF 1374/1 zur Verfügung, die statt der 10 kHz-Reihe eine 25 kHz-Reihe von Kontrollpunkten hat, die bis zu 200 MHz nutzbar ist.

EE 34 771 *für weitere Einzelheiten*

MICROCELL ELECTRONICS LTD

Blackwater, Camberley, Surrey

TRANSISTOR-NETZGERÄT

Type 410 ist ein Tisch-Netzgerät, das bei 5 A eine kontinuierlich regelbare Ausgangsspannung von 1 ... 30 V abgibt. Spannungspegel wird mittels Regeltransformator eingestellt, wodurch hohe Betriebssicherheit und Reproduzierbarkeit erreicht wird. Ausgangsspannung und -strom werden durch ein eingebautes Messgerät überwacht, und ein schnell ansprechender Unterbrecher schützt das Netzgerät und die externe Schaltung, sollte Überlastung auftreten. Das Gerät ist für Dauerbetrieb bei 35°C bemessen.

Das Gerät hat eine 19 Zoll-Frontplatte. Normalerweise wird es in einem Microcell-Gehäuse geliefert, ist aber auch für Gestelleinbau geeignet.

Der Ausgangswiderstand ist unter 0,01Ω und der Wechselstromwiderstand bis zu 100 kHz unter 0,3Ω. Das Reglerverhältnis ist 500 : 1 für 7,5% Netzschwankung am Eingang.

EE 34 772 *für weitere Einzelheiten*

STABILISIERTES HOCHSPANNUNGSNETZGERÄT

Type 411 ist ein hochbelastbares Hochspannungsnetzgerät mit zwischen 500 V und 3 kV kontinuierlich regelbarer Ausgangsspannung bei 10 mA Stromentnahme.

Das auf einer 19 Zoll-Frontplatte montierte Netzgerät ist für Gestelleinbau geeignet, wird aber normalerweise in einem Microcell-Gehäuse geliefert.

Sicherheitsmassnahmen fanden besondere Beachtung, und das Gerät ist äusserst betriebssicher im Gebrauch.

Bei voller Belastung hat die Restwelligkeit einen doppelten Spitzenwert von 17 mV, und das Regelverhältnis ist 2000 : 1 bei 2 kV 5 mA. Die Ausgangsimpedanz ist ungefähr 100Ω.

EE 34 773 *für weitere Einzelheiten*

THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

MEHRGANG-DREHKONDENSATOR

(Abbildung Seite 394)

Der Zweigangkondensator Type 28 ist besonders für Runfunkempfänger gedacht, deren Abstimmeinheit hohe Qualität erfordert.

Tonfrequente Mikrofonie wird durch ein stabiles Gehäuse und Plattenmikrofonie durch einen starren Rotorzusammenbau und grossen Plattenabstand im Oszillatorteil vermieden. Die Kapazitätshübe reichen für alle Wellenbereiche aus und sind besonders für das volle

Kurzwellenband ohne Verkürzungskorrektur geeignet. Eine sehr hochgradige Angleichgenauigkeit der Kapazität der beiden Pakete gibt dem Konstrukteur die Möglichkeit, Abstimmkreise mit nur geringfügigem, auf Falschangleichung des HF- und Oszillatorpaketes zurückzuführenden Verlust zu entwickeln.

Der Kondensator kann mit internem Getriebe ausgerüstet werden, für das Standard-Untersetzungen von 3 : 1, 6 : 1 und 8 : 1 lieferbar sind.

EE 34 774 *für weitere Einzelheiten*

110° ABLENKSPULEN

(Abbildung Seite 394)

Diese Ablenkspulenreihe ist für 110° Bildröhren mit 43 cm ... 58 cm Schirm bestimmt. Die Spulen werden auf Polypropylen-Pressteile gewickelt und können bei allen Temperaturen verwendet werden, die im Fernseher auftreten.

Zum Wickeln der Spulen werden besondere Formungsvorrichtungen benutzt, um überall ein unverzerrtes Raster und guten Fokus zu gewährleisten. Durch geringste Kopplung zwischen Zeilen- und Bildspulen kann die neuzeitliche Tendenz zur Vereinfachung von Bildablenkschaltungen voll ausgenutzt werden.

Die Spulen sind mit hoch- oder niederohmigen Wicklungen lieferbar, und die Magnete für die Bildsteuerung können wahlweise fest oder einstellbar sein.

In einer neu entwickelten Zentriervorrichtung wird ein mit Ferrit gefüllter Kunststoff benutzt, um die in herkömmlichen Zentriervorrichtungen auftretenden Leistungsverluste zu vermeiden. Der plastische Steuermagnet hat den weiteren Vorteil, dass der Magnetismus dauernd erhalten bleibt und keine Entmagnetisierung durch das Ablenkspulenfeld auftritt.

EE 34 775 *für weitere Einzelheiten*

MINIATUR-LAUTSPRECHER

(Abbildung Seite 394)

Dieser Lautsprecher hat einen Durchmesser von 57,2 mm und ist für moderne, transistorisierte Miniatur-Empfänger bestimmt.

Der Magnetkreis benutzt eine neue Konstruktionstechnik, durch die die Gesamttiefe auf ein Minimum reduziert wird: ein Stabmagnet wird in einen geteilten Aluminiumring eingesetzt, der in ein genau bearbeitetes Joch eingebaut wird. Diese Konstruktion ergibt einen kompakten, robusten Antrieb ohne Zusammenbaubolzen für den Magnet.

Der 57,2 mm Lautsprecher kann mit niederohmiger Sprechspule (8 ... 10Ω) für Benutzung mit Anpassungsübertrager oder mit hochohmiger Spule für direkten Anschluss an die Transistor-Schaltung geliefert werden.

EE 34 776 *für weitere Einzelheiten*

STABILITY CAPACITORS LTD

Commerce Estate, Raven Road, London, E.18

POLYESTER-KONDENSATOREN

(Abbildung Seite 394)

Diese Kondensatoren wurden im Zuge der Tendenz für Miniatur-Bauelemente eingeführt und sind sowohl für Transistor-Empfänger als auch für Allgemeinverwendung geeignet.

Sie sind im Kapazitätsbereich von 0,01 ... 0,1 μF für 125 V Betriebsgleichspannung lieferbar.

Der Bedarf für Kapazitätswerte in diesem Bereich wurde bisher entweder durch Papier- oder Metallpapier (MP-) Kondensatoren gedeckt. Gegenüber diesen beiden Typen bietet der Polyester-Kondensator viele Vorteile, da er kleiner als der Papier-Kondensator und wirtschaftlicher als der Metallpapier-Kondensator ist. Ausserdem ist Polyesterfolie gegen Feuchtigkeit unempfindlich und bis zu hohen Temperaturen beständig. Die Konstruktionsweise gibt eine sehr niedrige Selbstinduktion.

Die Kombination dieser Eigenschaft mit dem durch einen Hartzementüberzug gebotenen Schutz ergibt einen preisgünstigen Kondensator, der allen Anforderungen entspricht.

Polyester-Kondensatoren werden mit axialen Anschlussdrähten oder in einer neuen und kompakten Ausführung mit Einsteckfahnen für gedruckte Schaltungen (Patent angemeldet) geliefert.

EE 34 777 *für weitere Einzelheiten*

STRATTON & CO. LTD

Eddystone Works, Alvechurch Road, Birmingham 13

UHF-EMPFÄNGER

(Abbildung Seite 395)

Modell 770S ist ein Doppelüberlagerungsempfänger, der den Frequenzbereich von 500 MHz ... 1 GHz überstreicht. Die Eichungsunsicherheit ist unter 1%. Ein Quarzeicher gibt 10 MHz—Marken ab, die Frequenzeinstellung mit 0,01% Genauigkeit ermöglichen. Durch Abstimmen des zweiten Frequenzumsetzers wird Bandspreizung über ±10 MHz ermöglicht. Der 50Ω—Eingang ist koaxial und die Empfindlichkeit liegt bei 10 μV.

Der Empfänger benutzt eine erste ZF von 160 MHz mit 20 MHz Bandbreite und eine zweite ZF von 46,5 MHz; die Gesamtbandbreite ist 3 MHz. Ein Abstimm- und Signalpegelmessgerät sind vorgesehen.

EE 34 778 *für weitere Einzelheiten*

NF-EMPFÄNGER

(Abbildung Seite 395)

Der NF-Empfänger Type S850/2 wurde für Überstreichung des Frequenzbereiches 10 ... 600 kHz in sechs überlappenden Bändern ausgelegt. Durch regelbare Selektion, Quarzfilter und ein Tonfrequenzfilter wird eine hochwertige Unterscheidung empfangener Signale erzielt. Antenneneingänge für 75Ω und 300Ω, symmetrisch und unsymmetrisch, sind vorgesehen, und eine automatische Verstärkungsreglerschaltung hält den Ausgangspegel für Eingangsänderungen von 80 dB über 10 μV innerhalb 10 dB konstant.

Der Tonfrequenzgang ist zwischen 100 Hz und 6 kHz bis auf 6 dB flach, und die maximale Ausgangsleistung in eine 2,5Ω Ausgangsimpedanz ist ungefähr 1 W. Die Kopfhörerklemmen erlauben zufriedenstellende Benutzung hoch- oder niederohmiger Hörer. Ein 600Ω Ausgang kann symmetrisch oder unsymmetrisch benutzt werden.

Bis zu 100 kHz ist die Empfindlichkeit bei einem Geräuschabstand von 15 dB besser als 5 μV (Signalmodulation 30% mit 400 Hz) und für Frequenzen unter 100 kHz bei einem Geräuschabstand von 15 dB besser als 15 μV.

EE 34 779 *für weitere Einzelheiten*

SUFLEX LTD

54 Uxbridge Road, London, W.5

VERÄNDERBARE POLYSTYROL-KONDENSATOREN

(Abbildung Seite 395)

Diese Kondensatoren wurden für Konstrukteure eingeführt, die einen Polystyrol-Kondensator benötigen, der über einen kleinen Bereich veränderlich ist.

Das in einem dicht verschlossenen Gehäuse von 50,8 × 50,8 × 28,6 mm untergebrachte Bauelement ist über einen Bereich von 0,45 ... 0,5 μF kontinuierlich veränderbar. Die Einstellung geschieht mittels einer Kopfschraube und die Genauigkeit ist innerhalb 0,1%. Andere Werte sind auch mit 10% Kapazitätsänderung lieferbar.

EE 34 780 *für weitere Einzelheiten*

THERMIONIC PRODUCTS (ELECTRONICS) LTD

Hythe, Southampton, Hampshire

MAGNETBANDLAUFWERK MIT 8 GESCHWINDIGKEITEN

(Abbildung Seite 395)

Dieses Laufwerk mit acht Geschwindigkeiten ist für Digitalaufzeichnung bestimmt und wurde entwickelt, um alle für Magnetbandaufzeichnung erforderlichen niedrigen und mittleren Geschwindigkeiten zu geben. Geschwindigkeit und Laufwerkgang werden durch Drucktasten eingestellt. Sorgfältige Ausführung der elektrischen Verriegelung schliesst die Möglichkeit einer Band- oder Laufwerkbeschädigung aus.

Eine durch das Band getriebene Längenanzeige gibt genaue Platzanzeige bis zu 10 000 ft (3050 m).

Kopfträger und Führungsanordnung wurden für die grösstmögliche Anpassungsfähigkeit ausgelegt. Montage von bis zu vier Köpfen ist vorgesehen. Wenn seitlich schwenkbare Kopfträger erforderlich sind, können nur zwei Köpfe vorgesehen werden.

Übliche Bandführungsglieder werden normalerweise eingebaut, jedoch kann

eine einkantige Bandführung geliefert werden, wenn grosse Aufzeichnungsdichten erforderlich sind.

Das Laufwerk kann Bandbreiten von 12,7 mm, 19,05 mm und 25,4 mm aufnehmen. Die Geschwindigkeiten liegen zwischen 3,17 mm/s und 38,1 cm/s.

EE 34 781 *für weitere Einzelheiten*

VENNER ELECTRONICS LTD
Kingston By-Pass, New Malden, Surrey

FREQUENZ- UND ZEITMESSGERÄT

(*Abbildung Seite 395*)

Type TSA 3336 ist ein neues und vielseitiges Zeit- und Frequenzmessgerät, in dem ein umfangreiches Pflichtenblatt mit einer neuen einzeiligen Projektionsanzeige kombiniert ist.

Es enthält transistorisierte Einschubbausteine aus dem Venner-Fertigungsprogramm, und ein Anschluss für das transistorisierte Venner-Digitaldruckwerk TSA 65 sowie Lochstreifenaufzeichnung mittels der transistorisierten Venner-Lochstanzensteuerung TSA 101 können vorgesehen werden. Es kann auch eingebaut zur Vervollständigung eines Messwerterfassungssystems geliefert werden.

Das Gerät TSA 3336 kann Frequenzen (Vorgänge pro Zeiteinheit) bis zu 1 MHz, Umkehrfrequenzen (Intervall) und Zeitintervalle in Mikrosekunden oder grösseren Einheiten messen und einfache Zählungen durchführen. Ausserdem stehen die Ausgänge des thermostatgeregelten 1 MHz-Quarzoszillators und der Digitalteilerkette für externe Verwendung als "Uhr"-Ausgangsimpulse zur Verfügung. Rückstellung des Gerätes kann durch Fernsteuerung, durch Drucktaste auf der Frontplatte oder durch einen automatischen Verzögerungsschalter erfolgen.

Der quarzgesteuerte 1 MHz-Oszillator treibt sieben Dekadenteilerstufen. Weitere sechs Dekadenteilerstufen finden in der Zählkette Verwendung. Es werden durchweg binäre Elemente mit Gegenkopplung benutzt. Ausserdem werden die zugehörigen Durchlass-, Impulsformer- und Rückstellbausteine aus dem Venner-Programm eingebaut.

Der TSA 3336 ist mit einer sechsstelligen, einzeiligen Ziffernanzeige mit automatischer Kommaeinstellung ausgerüstet. Ausserdem gibt eine siebente Anzeige die benutzten Einheiten, z.B. kHz, ms usw. an. Drehskalen-Anzeiger einer neuen, patentierten Konstruktion werden benutzt. Dadurch wird eine eindeutige Anzeige gewährleistet, die aus beträchtlicher Entfernung beobachtet werden kann und nicht ungebührlich gerichtet ist. Eine neben der Auslesung vorgesehene rote Signallampe zeigt an, dass der thermostatgesteuerte Ofen in Betrieb ist. Durch federleichte Drucktasten betätigte Mikroschalter werden für "Rückstellung 0", "Rückstellung 9", "Stop" und "Start" benutzt.

EE 34 782 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Der Signalwächter: Ein Festkörper-Uberwachungs- und Warnsystem von M. L. Klein und J. P. Hart

Zusammenfassung des Beitrages auf Seite 344-348

In Verfahrensüberwachung, Medizin und Qualitätskontrolle besteht Bedarf für ein Festkörper-Präzisions-Uberwachungs- und Warnsystem. Der Signalwächter hat für Mehrfach-Gleichstromeingangspegel eine Monitorgenauigkeit von 0,1%. Ausserdem werden 12 kritische Spannungen im Gerät von einem Monitor überwacht. Das Gerät besteht aus einem Festkörper-Abtastgerät und einem volltransistorisierten Digitalvoltmeter. Lochkarten-Programmierung und logische Schaltungen werden benutzt. Alle mit dem Programm übereinstimmenden Daten fallen aus; nicht übereinstimmende Daten geben die Warnung. Die Abtastung von 30 Kanälen in unter 30 ms ermöglicht Einsatz für kritische Verfahrensüberwachung.

Eine niederohmige, besonders für Filter geeignete Kondensatorkonstruktion von C. W. McCutchen und I. D. Howard

Zusammenfassung des Beitrages auf Seite 349-353

Verschiedene Methoden zur Herabsetzung des induktiven Serienwiderstandes normaler Kondensatoren werden untersucht. Die Eigenschaften des wirksamen kapazitiven Teils solcher Kondensatoren werden beschrieben, und die dadurch erworbenen Kenntnisse führten zu einer verbesserten Methode für Filterkondensator-Anschlüsse, durch die die Kondensatorverluste die Siebung unterstützen.

Kenndaten und Verwendung von Glimmröhren von F. A. Benson

Zusammenfassung des Beitrages auf Seite 354-359

Neuste Untersuchungen zur Bestimmung der Kennlinien und Beschränkungen von Glimmröhren werden besprochen. Zunächst wird der Einfluss der Anderung des Argongehaltes von Neon-Argon-Bezugsröhren, die Verwendung von Krypton und Xenon als Beimischung und die Kenndaten von Helium-Neon und Helium-Argon Gasgemischen erörtert. Die Eigenschaften einkristalliner, mehrkristalliner und aktivierter Kathoden werden beschrieben. Die folgenden Abschnitte behandeln Anderungen des Gasdruckes, des Temperaturbeiwertes der Brennspannung, Rauschen, Metall-keramikröhren, Impedanzkenndaten und Hohlkathodenröhren, Zerstäubung, Fotoeffekte, Gasreinigung und verschiedene andere Eigenschaften. Schliesslich werden Verwendungszwecke erwähnt.

Der Transistor als temperaturempfindliches Element in Temperatur-Steuersystemen von J. E. Pallett

Zusammenfassung des Beitrages auf Seite 360-363

Die Verwendung eines Transistors in Basisschaltung zum Nachweis von Temperaturänderungen in temperaturgesteuerten Systemen wird eingehend untersucht. Es wird gezeigt, dass der Hauptvorteil über andere Methoden in der hohen Empfindlichkeit liegt, die bis zu 1 V/°C betragen kann, für Ge-Transistoren aber auf Temperaturen von ungefähr 90°C und für Si-Transistoren auf ungefähr 150°C begrenzt ist.

Pulserzeugung im Corsair-Digital-Differentialanalysator von P. L. Owen, M. F. Partridge und T. R. H. Sizer

Zusammenfassung des Beitrages auf Seite 364-371

Der erste einer Serie von vier Beiträgen, in denen die Berechnung und Schaltungseinzelheiten des transistorisierten Digital-Differentialanalysators Corsair beschrieben werden, behandelt die Erzeugung der Steuerimpulse. Im wesentlichen ist die Theorie der Erzeugung zwar nur eine der Impulsteilung, jedoch ist die dafür benutzte Methode ungewöhnlich, besonders wo es sich um Parallellogik in der Maschine handelt.

Boolesche Symbole in der Schaltelement-Wartung von S. Alexander

Zusammenfassung des Beitrages auf Seite 372-374

Für Schaltelemente wird unter besonderer Berücksichtigung der Aufstellung von Prüf- und Wartungsprogrammen eine symbolische Schreibweise vorgeschlagen. Das System stützt sich auf die in der Konstruktion von Schaltungsverknüpfungen bereits weitgehend benutzte Boolesche Algebra. Unter den verschiedenen angegebenen Beispielen ist besonders ein Prüfprogramm zu erwähnen.

Eine neue Schnellmethode zur Berechnung von Transistor-Verstärkerschaltungen von R. R. Vierhout und A. J. H. Vendrik

Zusammenfassung des Beitrages auf Seite 375-381

Wenn der Hybridenparameter h_{12} vernachlässigt wird, wie es bei praktischen Berechnungen getan werden mag, kann der Transistor in einer Weise als Stromverstärker behandelt werden, die der der Röhre als Spannungsverstärker analog ist. Eine nützliche Grösse ist der Rückwirkungswiderstand, mit dessen Hilfe viele Kenndaten gegengekoppelter Schaltungen leicht berechnet werden können. Es wird gezeigt, dass mit einer Spezialgegenkopplung Eingangswiderstände von mehreren Megohm erreicht werden können.

Verschiedene Mittel zur Verbesserung der Temperaturstabilität von Transistorschaltungen werden besprochen, wobei eine einfache Berechnungsmethode benutzt wird. Formeln für das Rauschen in Transistorschaltungen werden abgeleitet.

Ein Ubertragungsfunktions-Analysator für lineare und nichtlineare Bauelemente von A. K. Choubhury, M. S. Basu und A. K. Mahalanabis

Zusammenfassung des Beitrages auf Seite 382-385

Der Beitrag beschreibt ein Messverfahren für Frequenzgang, Verstärkung und Phase linearer und nichtlinearer physikalischer Bauelemente. Für das Verfahren werden Standard-Widerstände und -Kondensatoren sowie im elektronischen Labor normalerweise zur Verfügung stehende Hilfsmittel benutzt. Es gibt gute Genauigkeit über einen umfangreichen Frequenzbereich mit äusserst niedrigen Anfangswerten. Messwerte einiger nichtlinearer Kennlinien werden angegeben.

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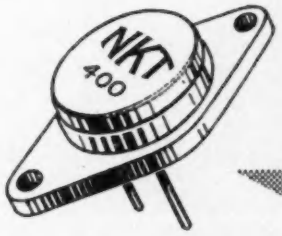

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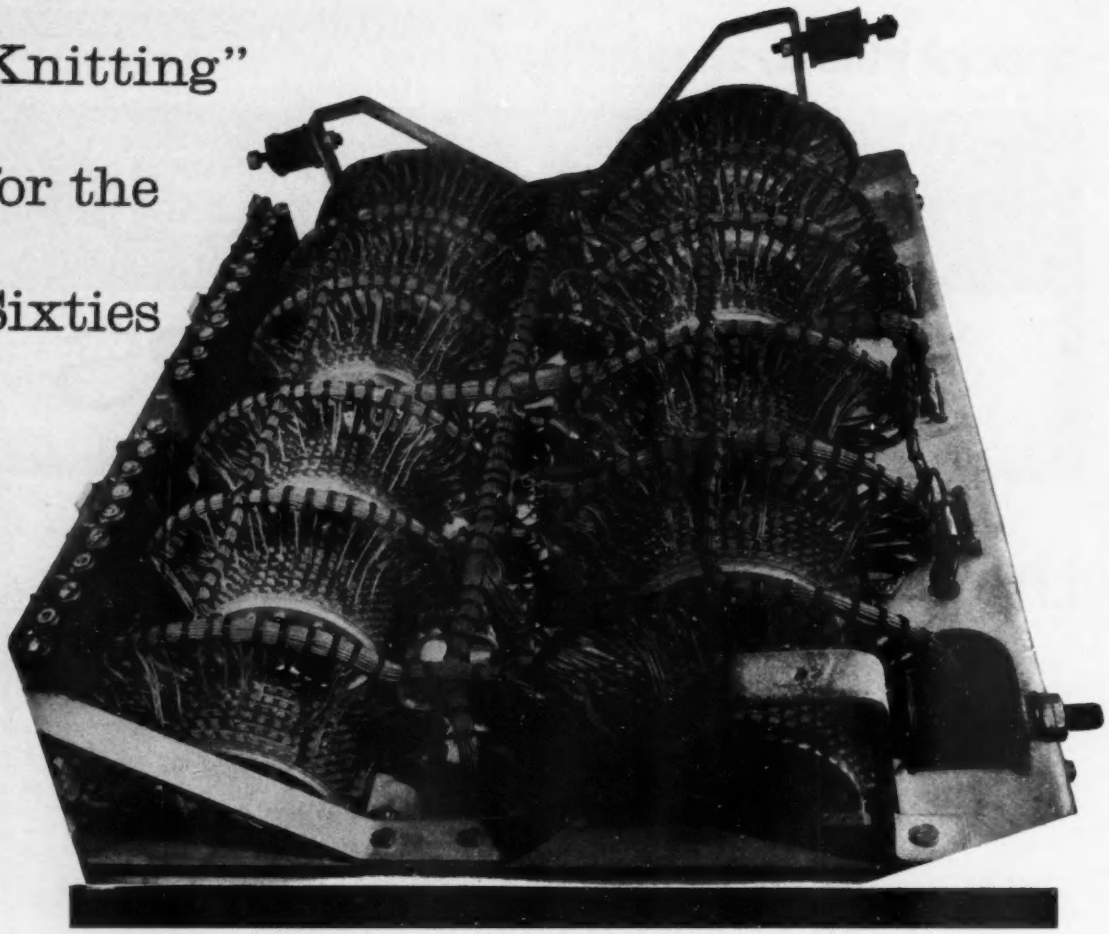

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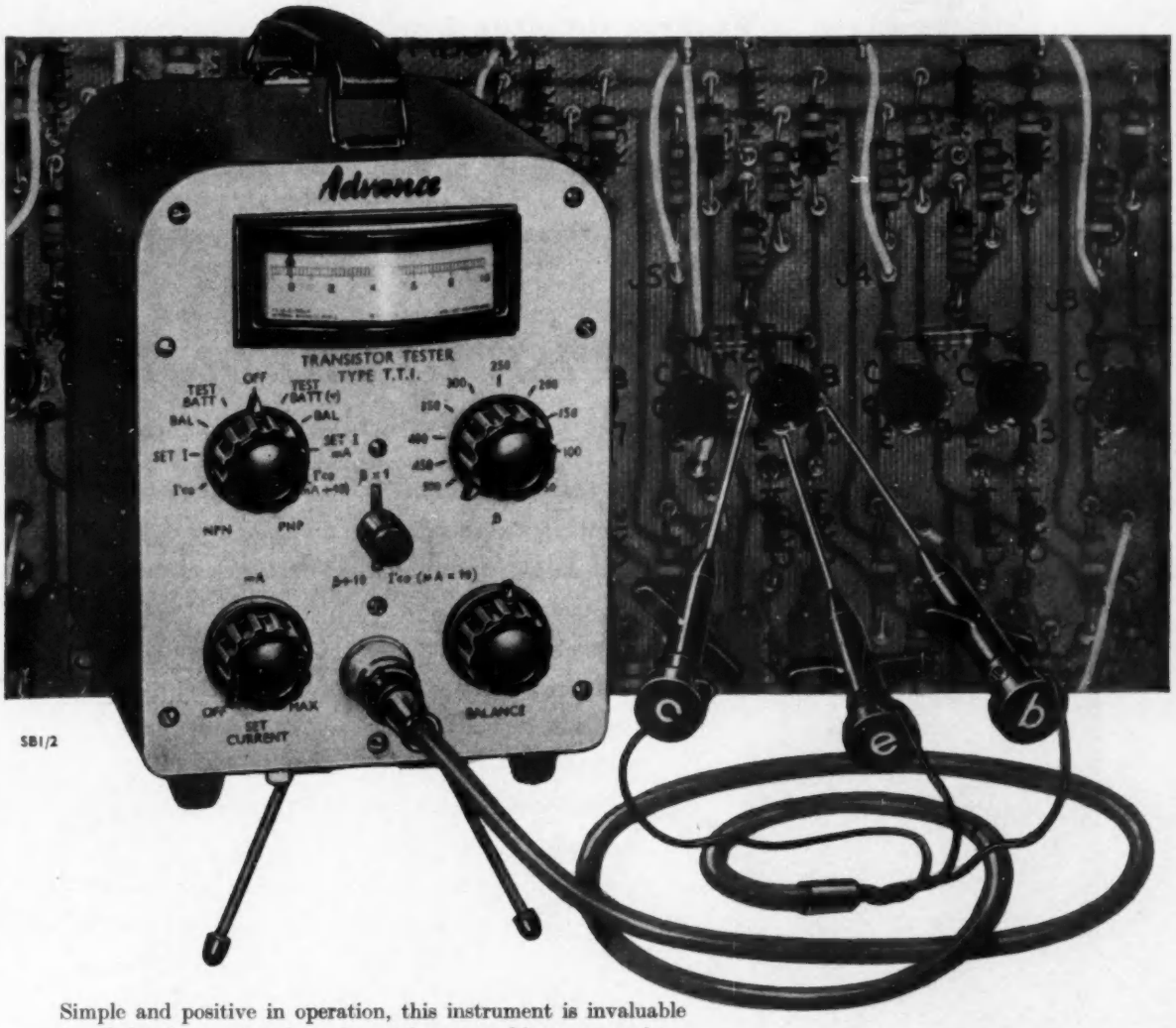

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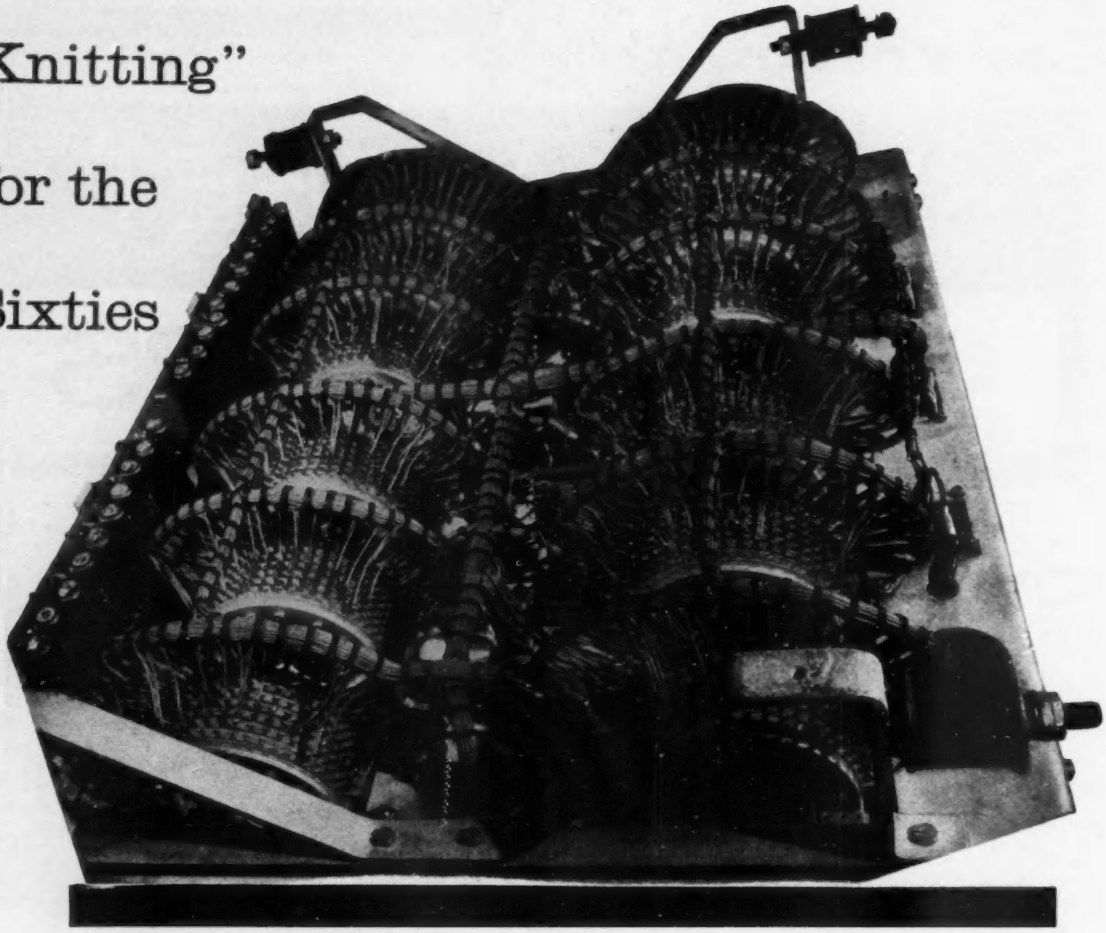

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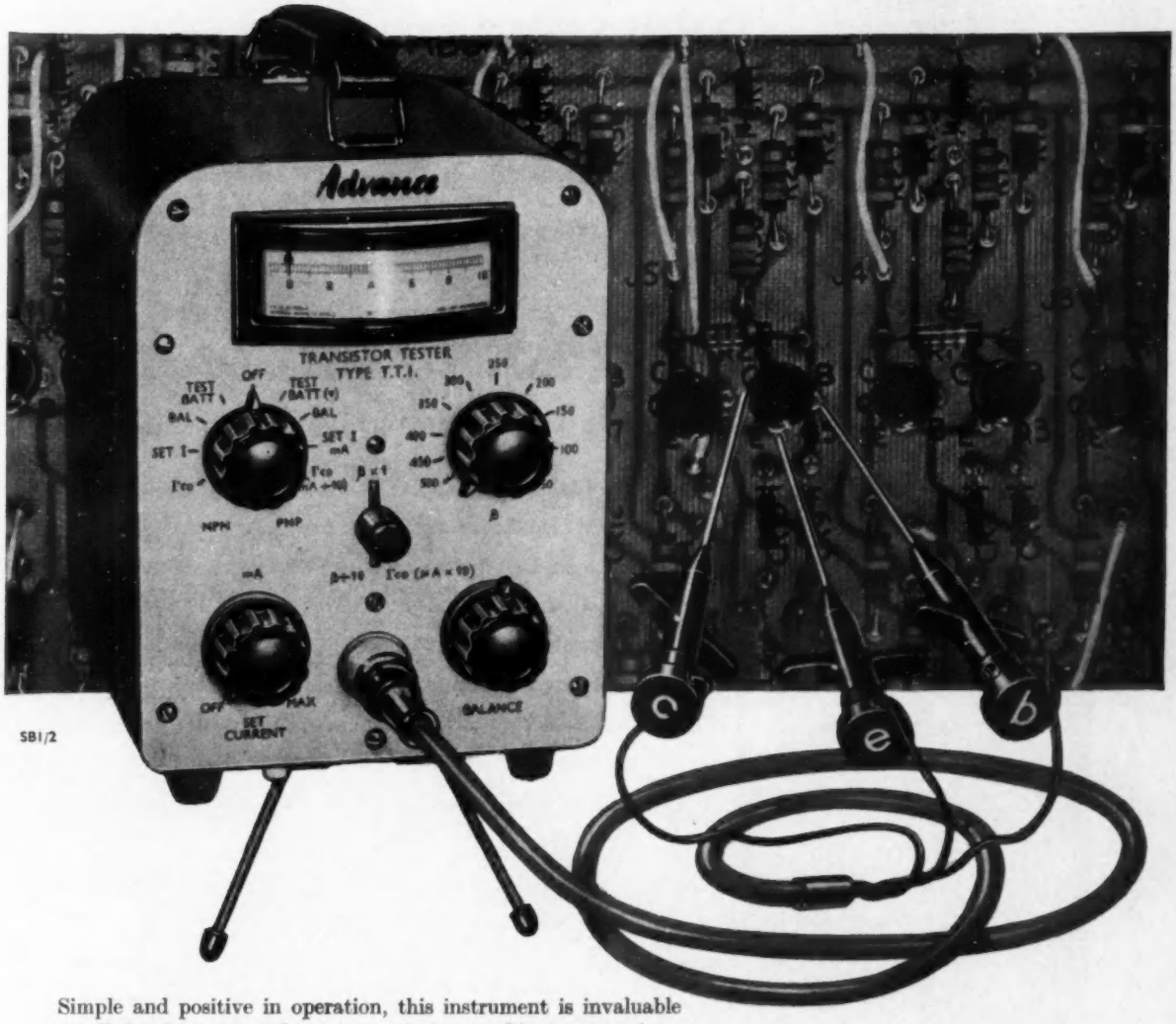

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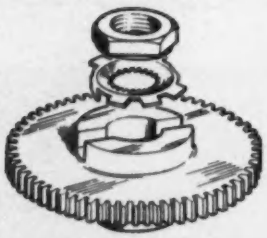

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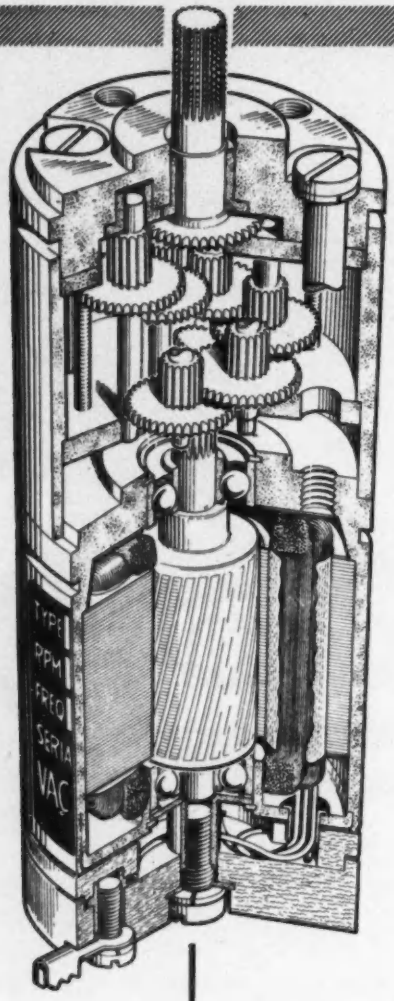

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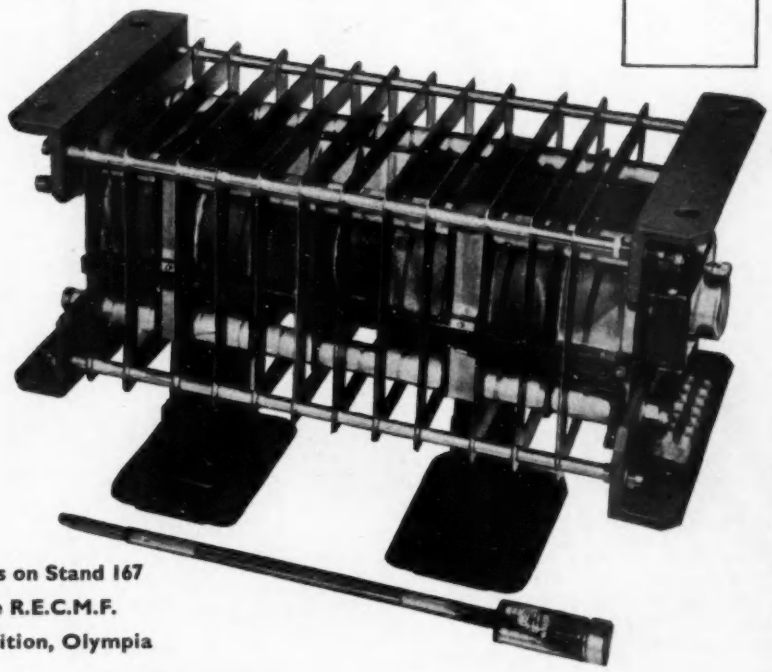

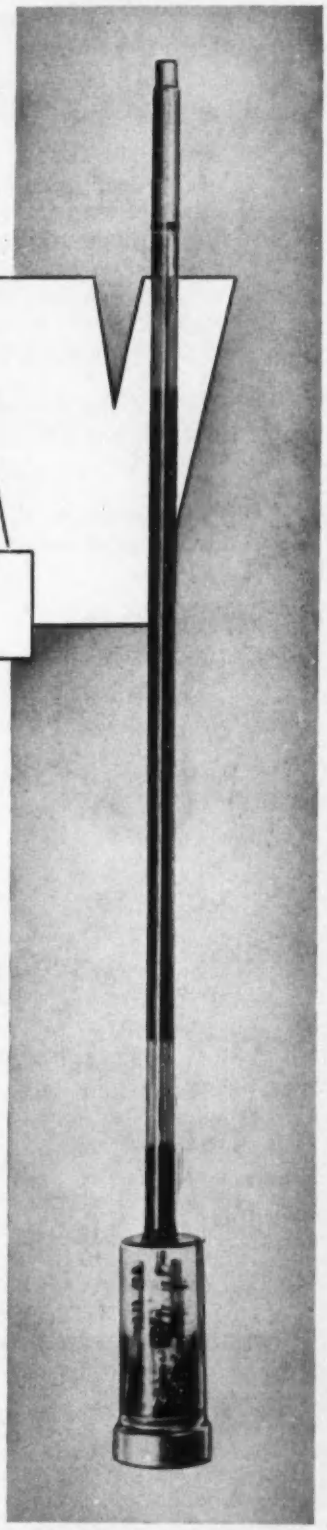

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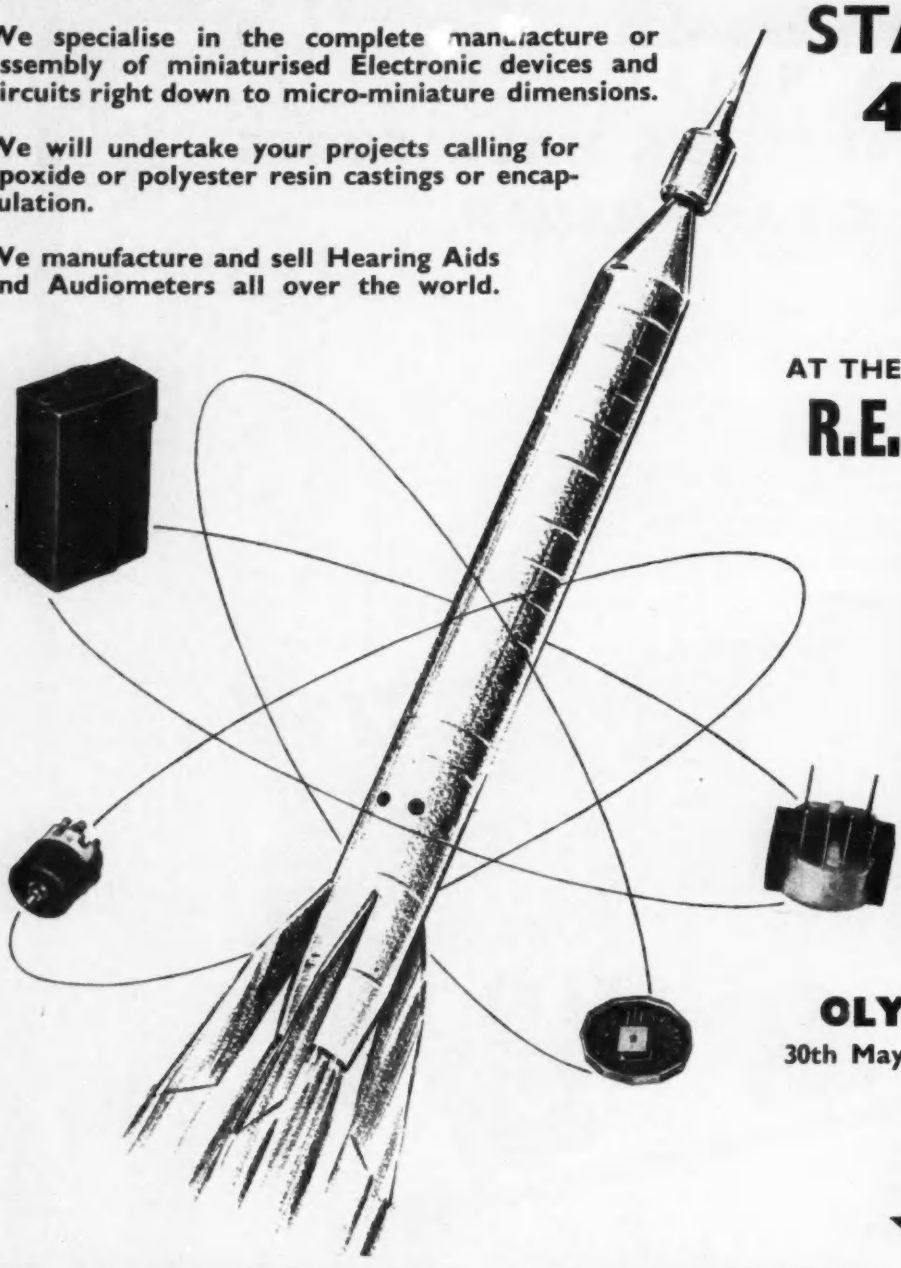

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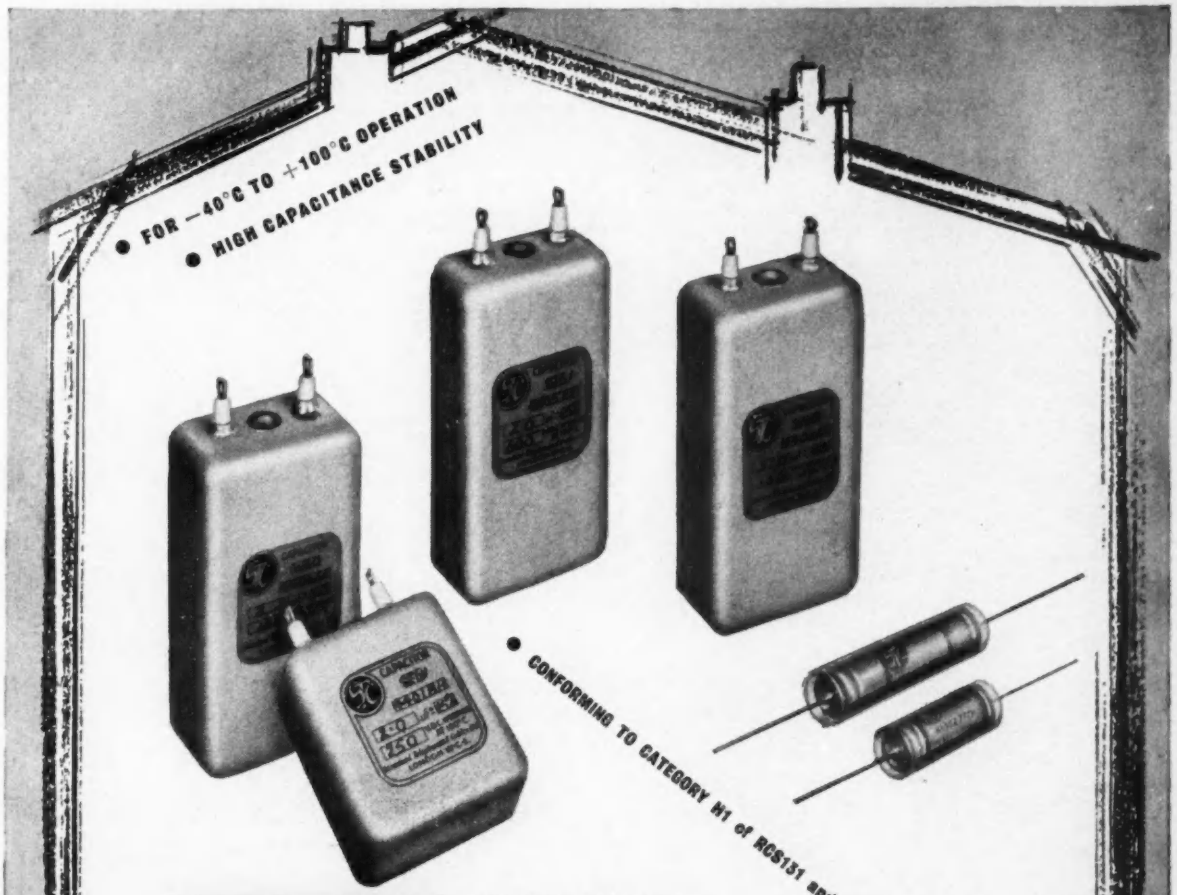

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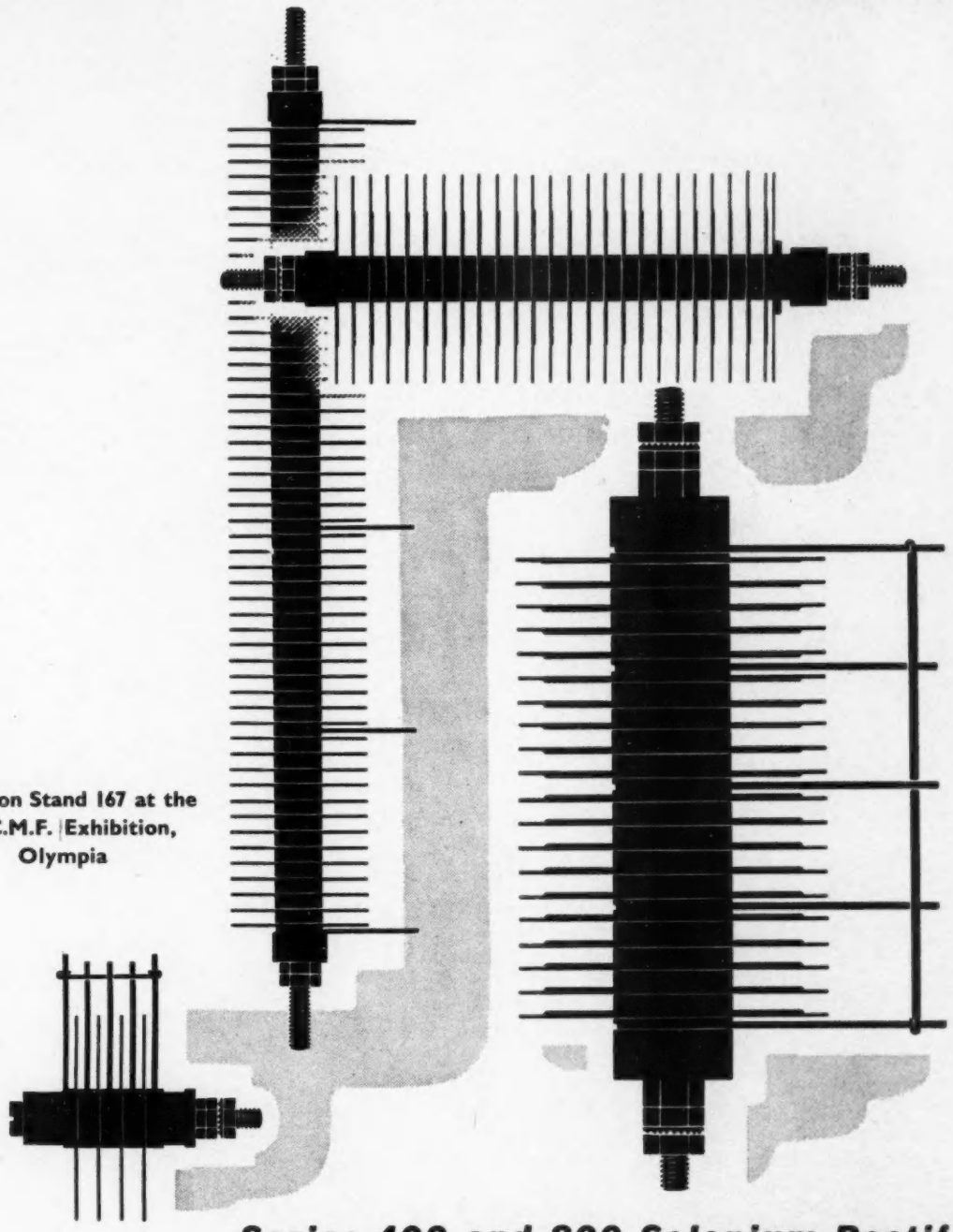

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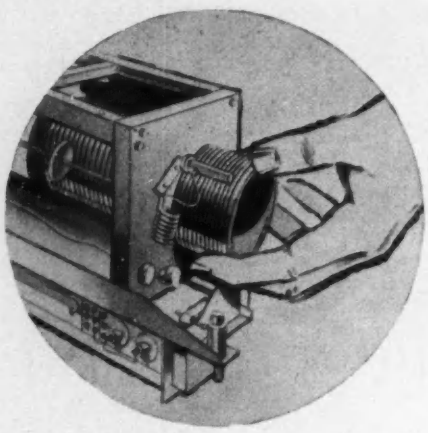

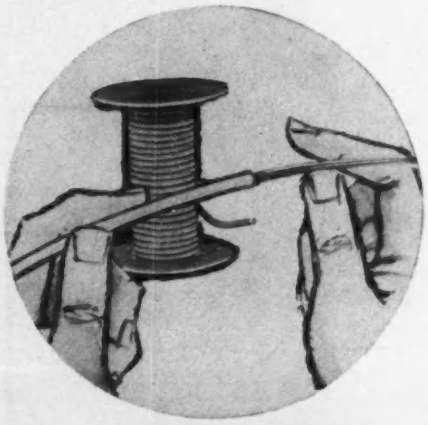

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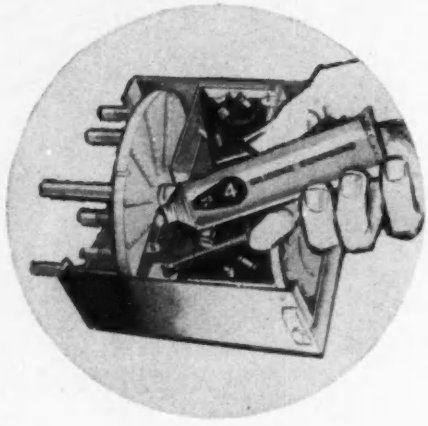

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HS1004	50	170 mA	100 mA	·050 μA	5 μA
HS1005	50	170 mA	100 mA	·100 μA	—
HS1006	50	170 mA	100 mA	·200 μA	—
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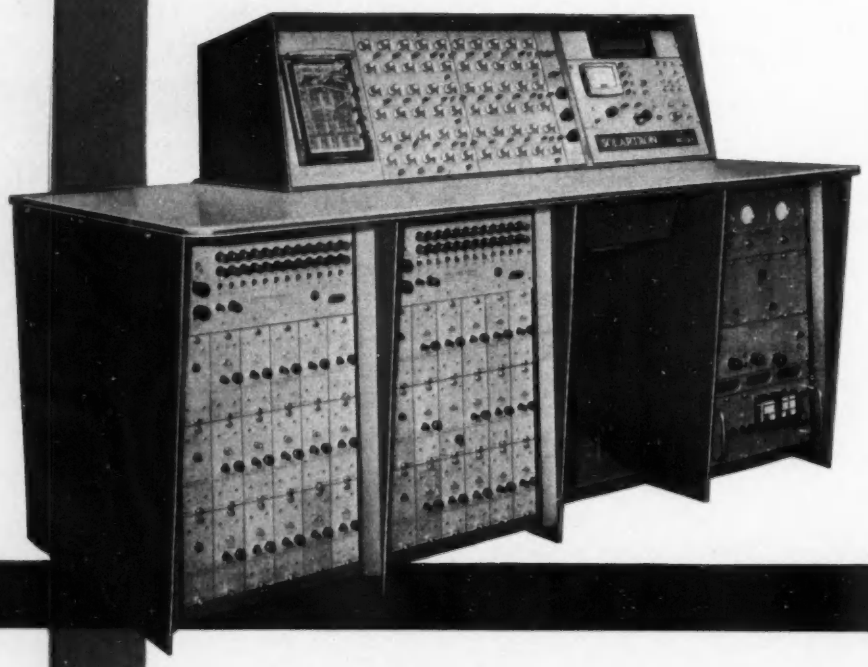

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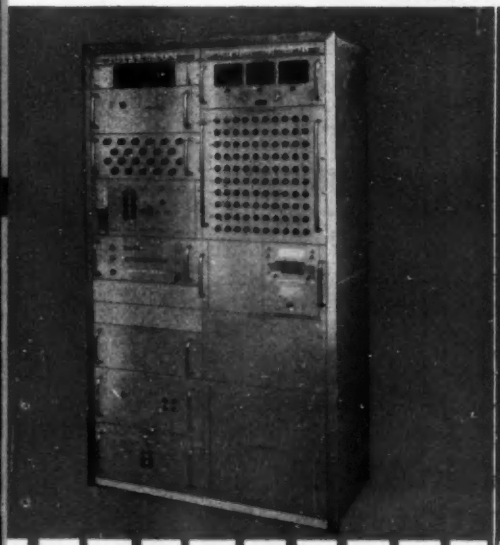
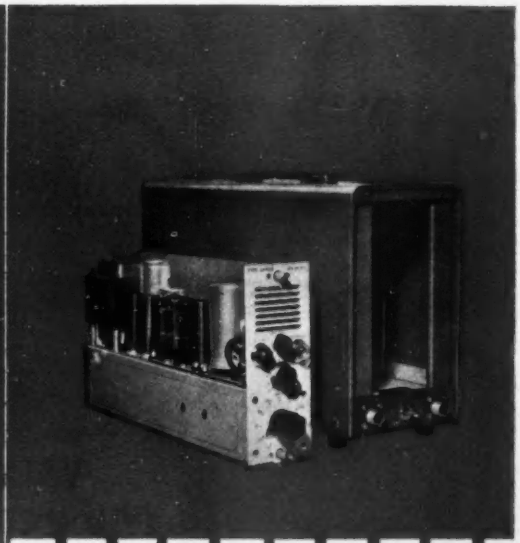
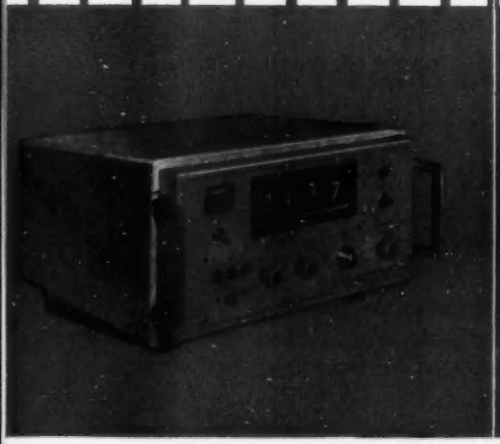




★ HIGH GAIN
★ LOW DRIFT
★ LOW NOISE

Gain: 20 x to 1000 x in 10 steps, with continuous 1 to 2 x variation on each step. (D.C.—40 kc/s)
Drift: 2 μV in 40 hours
Z_{in}: 100 k Ω
Z_{out}: 1 Ω in series with 25 μH
Output: $\pm$ 35 Volts into loads > 1 k Ω, $\pm$ 35 mA pk.



SOLARTRON Electronic Equipment

comprises precision built units of high accuracy and reliability, designed to function either as complimentary units in large installations, or to operate as independent instruments in Production, Research or Development work.

4-Figure D.C. Digital Voltmeter LM 902.2

★ 100 μV to 1.599 kV (in 5 ranges)
★ Accuracy $\pm$ 0.1% of full scale on each range.
★ Automatic polarity discrimination.
★ 280 milliseconds Read-out Time.
★ Adjustable 'Dead Zone' to eliminate jitter.

5-Figure D.C. Digital Voltmeter LM 1010

★ 0–0.15998 V to 0–1.5999 kV (in 5 ranges)
★ Accuracy 0.05%. Resolution 0.01%. (Max. 20μV)
★ 1000 M Ω input impedance, suitable for capacity transfer techniques.
★ Up to 60 conversions/sec.
★ Direct Reading Thermocouple Ranges.

For full details of the Solartron range of electronic instruments and equipment, write to any of these addresses–

W. GERMANY Solartron Elektronik GmbH, Munich 15. *Tel:* Munich 59.51.09 ● **HOLLAND** Solartron (Nederland) N.V., The Hague. *Tel:* The Hague 543147 ● **ITALY** Solartron S.p.A., Milan. *Tel:* Milan 412 396 ● **SWEDEN** A.B. Solartron, Stockholm NO. *Tel:* Stockholm 600906 ● **FRANCE** Solartron France S.A., Paris 20e. *Tel:* Pyrenées 4840 ● **UNITED STATES** Solartron Inc., Anaheim, California. *Tel:* Prospect 2-2652 *There are Solartron agents throughout the world.*

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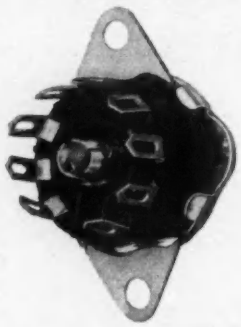
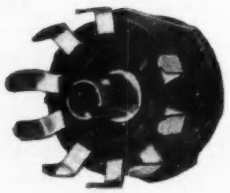
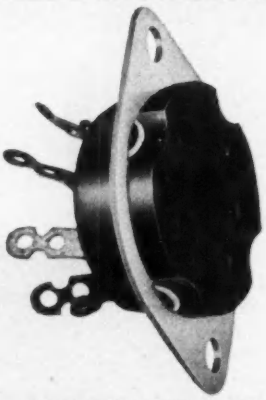


B9A VALVEHOLDER FOR CHASSIS MOUNTING



B9A VALVEHOLDER FOR PRINTED CIRCUITS



INTERNATIONAL OCTAL VALVEHOLDER

VALVEHOLDERS FOR PRINTED CIRCUITS AND CHASSIS MOUNTING

Now you can cut the cost of your product without taking chances with quality. Clix prices are down, and we've done it by efficient production planning and modern equipment—not by skimping materials, finish or workmanship.

These B9A valveholders show you what we mean—all tags are readily bendable. Bell-mouth contacts give reliable, low contact resistance. The saddled version will take either spring retainers or Clix screening cans yet they are smaller than the normal skirted types. We can also supply them with a reverse saddle for under chassis mounting and a loose skirt for bayonet type screening cans.

The International Octal Valveholder illustrated can be mounted above or below the standard 1⅛" chassis hole. 6-point contacts give low electrical resistance with smooth-insertion too, and *really* bendable tags. We'll be happy to send you samples and talk prices.

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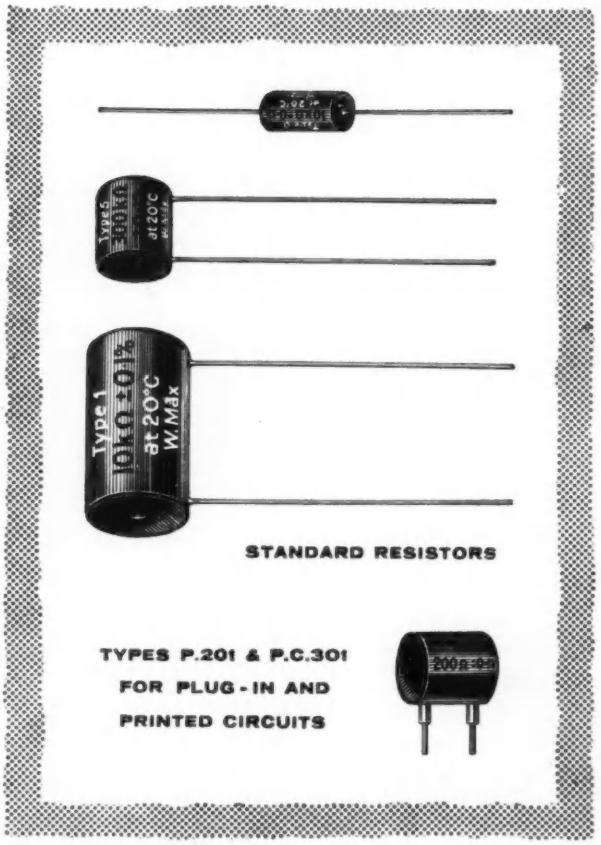
Even higher quality in **quantity!** through advanced techniques and extended capacity...

RIVLIN

precision wirewound resistors



STANDARD RESISTORS

TYPES P.201 & P.C.301
FOR PLUG-IN AND
PRINTED CIRCUITS

NEW ENCAPSULATION METHOD

Rivlin Instruments Limited have developed a new method of encapsulation, based on epoxy resin, which has the following advantages:—

Wide Temperature Range—Proof against High Humidity. Suitable for use in the temperature range -55°C to +120°C with or without humidity, without significant effect on accuracy and stability.

Improved Stability. The new method results in resistors having stability of a very high order.

Interchangeability. The new range is completely interchangeable with the existing RIL types (1-9) and all dimensions are exact and repeatable within close limits.

Precious Metal Plated Terminations. In accordance with the best modern practice, the terminations are gold plated for ease of soldering and to prevent oxidation during storage.

STANDARD RANGE

Rating ¼W to 3W. Range 0.1Ω to 3MΩ tolerance to ±0.1% of nominal value or 0.01Ω whichever is the greater. Terminals, wire leads or solder lugs, fixing studs can be fitted.

PLUG-IN

Rating ¼W (other ratings to order). Range 50Ω to 200KΩ, tolerance ±0.1%. Designed for rapid range changing in recorders, computing networks, voltage dividers, etc. Phosphor bronze pins, gold plated for low contact resistance, plug into Electro Methods type D2 socket (special spacings to order).

PRINTED CIRCUIT

Rating ¼W (other ratings to order), range 50Ω to 200KΩ, tolerance ±0.1%. Designed specifically for Printed Circuit use with Phosphor Bronze pins, silver finished, spaced to suit standard Printed Circuit module.

NEW PRODUCTION CAPACITY

By the recent completion of additional factory, laboratory and office buildings our capacity and scope have literally tripled. Delivery is now 3 to 6 weeks according to size of order. Where high accuracy and consistent performance are vital considerations then RIVLIN is the resistor to specify.

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Full technical data available on request.

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Yorktown Industrial Estate, Doman Road, Camberley, Surrey
Tel: Camberley 2507/8 Grams: Rivlectron Camberley London Office. Tel: Swiss Cottage 3038

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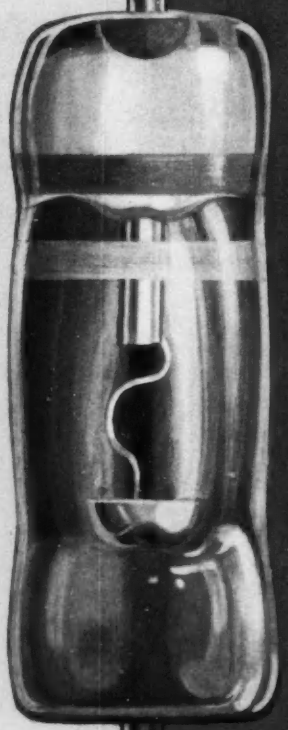

Gold Bonded

DIODES

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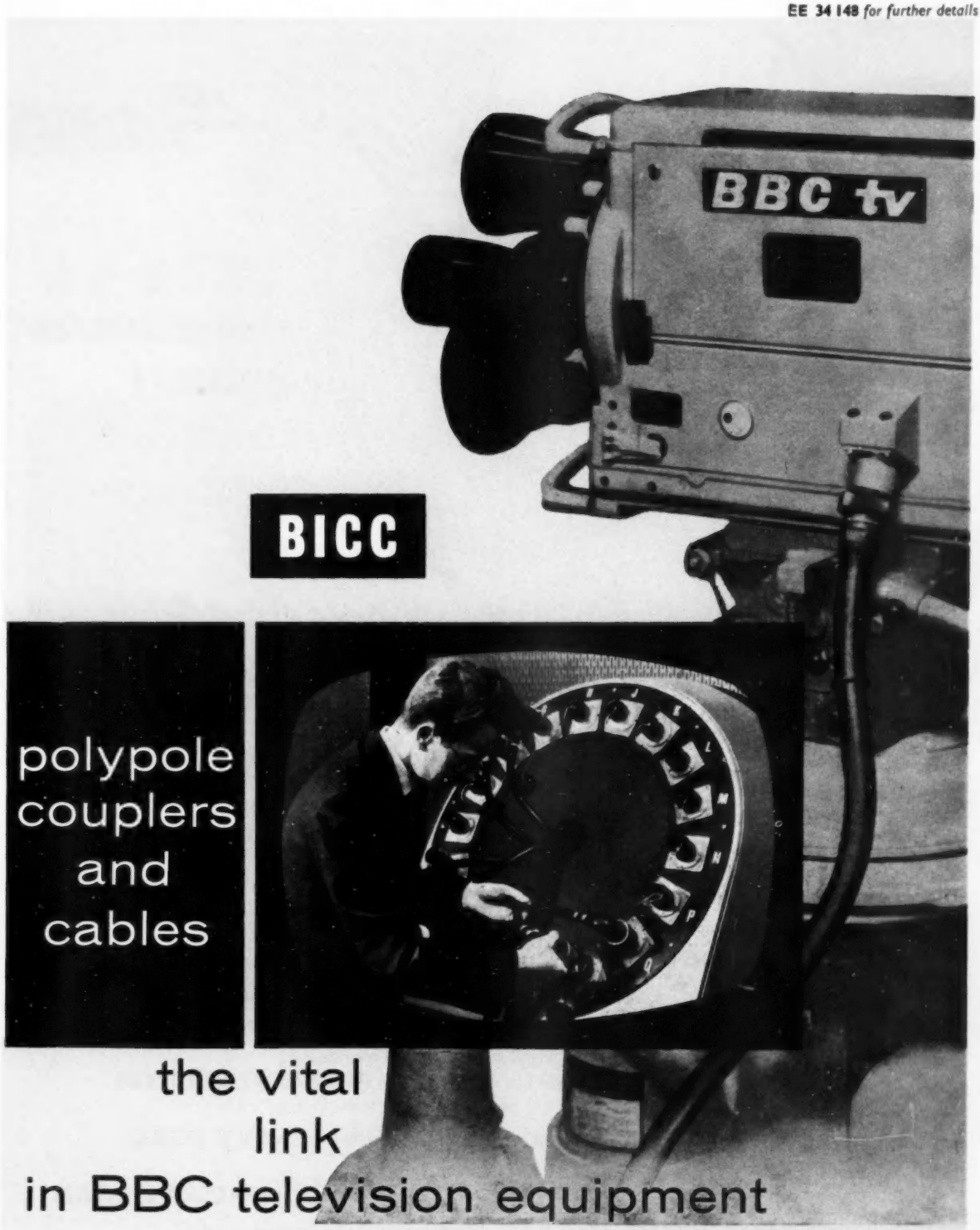

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THE JLT Statham "DIMENSIONLESS" UNBONDED STRAIN GAUGE TRANSDUCER

A new concept in transducer design for

★ HIGH ACCURACY

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★ TEMPERATURE COEFFICIENT UNCOMPENSATED BETTER THAN 0·005% PER DEGREE F.

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TRANSISTORISED A.C. VOLTAGE REGULATOR

MODEL T200

Exceptional reliability coupled with precision performance. Combination of semi-conductor and magnetic design techniques gives fast response time. Suitable for incorporation in larger equipments where reliability and long service are of prime importance.

Output regulation: ± 0·25% for ± 10% change in input voltage.

Distortion: less than 3%.

Power factor range: 0·9% leading to 0·7 lagging.

Time Constant: 0·1 seconds.

Weight: 20 lbs. only.

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Only Transitron offers

SILICON TRANSISTORS

FEATURES

- Low I_{CO}
- High Temperature Reliability
- Mechanical Ruggedness
- Broad Power Range
- Extreme Compactness

SMALL SIGNAL

HIGH FREQUENCY (TO-18)

Type	Minimum DC Common Emitter Current Gain β	Maximum Collector Voltage V_{cb} (volts)	Typical Cut-off Frequency (Mc)	Maximum Collector Cut-off Current @ 25°C @ V_c max (μA)
2N754	20.	60.	65.	1.
2N755	20.	100.	65.	1.
2N842	20.	45.	45.	1.
2N843	45.	45.	65.	1.
2N844	40.	80.	85.	1.
2N845	40.	100.	85.	1.

INTERMEDIATE POWER

INTERMEDIATE POWER STUD-MOUNTED

Type	Maximum Power Dissipation at 100°C Case (watts)	Maximum Collector Voltage V_{cb} (volts)	Minimum DC Common Emitter Current Gain, β	Typical Collector Saturation Resistance (ohms @ amps)
2N1647	20.	80.	15. @ 500mA	1.8 @ 1.
2N1648	20.	120.	15. @ 500mA	1.8 @ 1.
2N1649	20.	80.	30. @ 500mA	1.8 @ 1.
2N1650	20.	120.	30. @ 500mA	1.8 @ 1.
2N1896	20.	60.	20. @ 500mA	3.0 @ 1.

SILICON CONTROLLED RECTIFIER

TRANSITRON continues to offer the broadest line of Silicon Controlled Rectifiers in the industry. Available in five different and versatile packages, these rugged devices offer greater reliability and efficiency while replacing thyratrons, magnetic amplifiers, and other switching devices in many varied applications.

NEW 50 amp TYPE

. . . A three-terminal, four-layer device designed to control very large load currents with small gate current signals.

Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current at 90°C case (amps)	Package Configuration
TCR4050	400	50	1 1/16" hex
TCR3050	300	50	1 1/16" hex
TCR2050	200	50	1 1/16" hex
TCR1050	100	50	1 1/16" hex
TCR550	50	50	1 1/16" hex

Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current (amps) at 25°C case	at 100°C case	Package Configuration
TCR1020	100.	20.	10.	1 1/16" hex
TCR2020	200.	20.	10.	1 1/16" hex
TCR3020	300.	20.	10.	1 1/16" hex
TCR4020	400.	20.	10.	1 1/16" hex
TCR1010	100.	10.	5.0	1 1/16" hex
TCR2010	200.	10.	5.0	1 1/16" hex
TCR3010	300.	10.	5.0	1 1/16" hex
TCR4010	400.	10.	5.0	1 1/16" hex
TCR1005	100.	5.0	3.0	7/16" hex
TCR2005	200.	5.0	3.0	7/16" hex
TCR3005	300.	5.0	3.0	7/16" hex
TCR4005	400.	5.0	3.0	7/16" hex
2N1600	50.	3.0	3.0*	7/16" hex
2N1601	100.	3.0	3.0*	7/16" hex
2N1602	200.	3.0	3.0*	7/16" hex
2N1603	300.	3.0	3.0*	7/16" hex
2N1604	400.	3.0	3.0*	7/16" hex
2N1595	50.	0.6**	1.0*	TO-5
2N1596	100.	0.6**	1.0*	TO-5
2N1597	200.	0.6**	1.0*	TO-5
2N1598	300.	0.6**	1.0*	TO-5
2N1599	400.	0.6**	1.0*	TO-5

* At 80°C case ** At 25°C ambient

tomorrow's solutions today!

MICRO-COMPONENTS

Significant developments by Transitron in all-glass packaging have made possible the addition of new major components to what is already the broadest line of silicon miniature devices in the industry today . . .

With the introduction of all-glass packaging, Transitron now has been able to achieve TRUE hermetic sealing for its **entire** line of silicon microcomponents! . . . All units are completely compatible with present circuitry . . . All provide the same excellent performance as larger Transitron devices in 1/5th to 1/20th the space.

MICRO ZENER DIODES

(SPECIFICATIONS AT 25°C)

Type	Nominal* Voltage (volts)	Test Current (mA)	Maximum Dynamic Resistance (ohms)	Maximum Inverse Current @ E_b = —1 Volt (μA)	Typical Forward Voltage @ 5·0mA (volts)
TMD-01	5.1	5	15	1.0	0.75
TMD-02	5.6	5	15	1.0	0.75
TMD-03	6.2	5	15	1.0	0.75
TMD-04	6.8	5	15	1.0	0.75
TMD-05	7.5	5	15	0.1	0.75
TMD-06	8.2	5	15	0.1	0.75
TMD-07	9.1	5	15	0.1	0.75
TMD-08	10.0	5	15	0.1	0.75
TMD-09	11.0	5	20	0.1	0.75
TMD-10	12.0	5	20	0.1	0.75

*Voltage Tolerance ± 10%. For ± 5% Voltage Tolerance use "A" suffix (i.e. TMD-01A)

FAST SWITCHING

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time (μsec)
TMD24	50	50	0.3
TMD25	100	50	0.3
TMD27	200	50	0.3

VERY FAST SWITCHING

TMD50	60	20	.004

SILICON AND GERMANIUM DIODES

- High forward conductance
- High voltage ratings
- Fast switching time
- Low shunt capacitance
- Subminiature size

SAMPLES OF THE WIDE RANGE CURRENTLY AVAILABLE:

IN914 and IN916 SILICON COMPUTER TYPES

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time ($m_\mu$sec)	Maximum Capacitance at 0 Volts ($\mu\mu$f)
IN914	75.0	75.0	4.0	4.0
IN916	75.0	75.0	4.0	2.0

IN695A GERMANIUM COMPUTER TYPE

(At 25°C except where otherwise indicated)	N695A
Maximum Forward Voltage Drop (volts @ mA)	0.5 @ 10
	1.0 @ 100
Maximum Inverse Current (μA @ volts)	2 @ —10
	20 @ —10*
	10 @ —20
Maximum Inverse Pulse Recovery Using JAN 256 Circuit (Recovering to 200 μA)	0.3 μsec

*At 70°C

SPECIAL PRODUCTS

In addition to a wide range of components, Transitron also offers Special Products and Devices to meet your requirements. We welcome inquiries and offer engineering advice on your particular needs.

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INS. 59

Minimum space . . . .

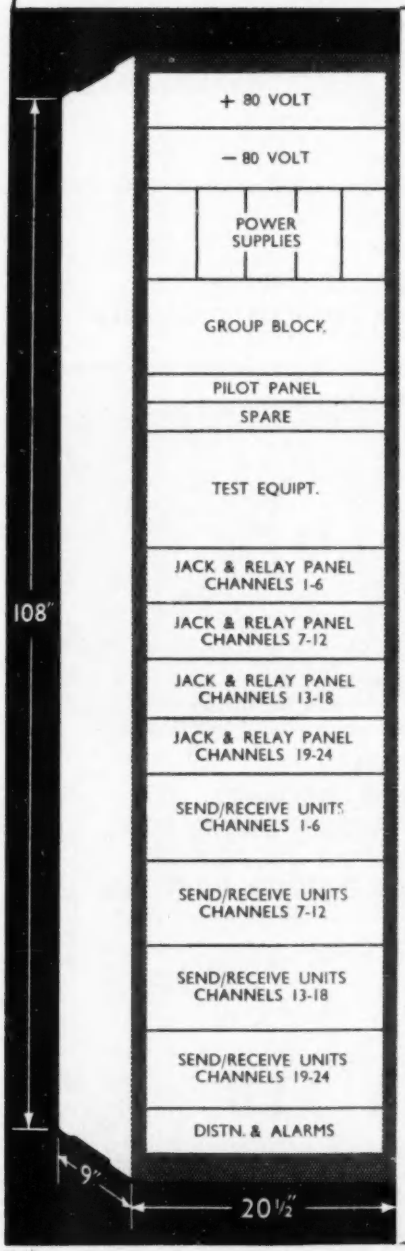
Minimum power consumption . . . .

Minimum maintenance . . . .

AEI Transistorised FMVFT

TYPE CT 24A

FOR THE PROVISION OF TELEPRINTER OR DATA TRANSMISSION CIRCUITS



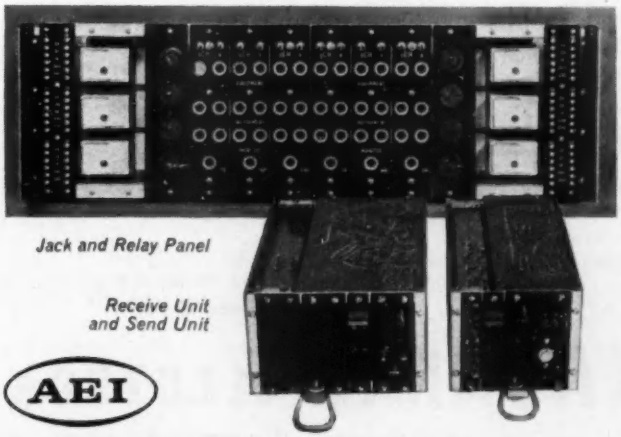
FD 8/9

* CCITT standards of performance
* 24 channels per rackside
* 50 baud nominal, with operation up to 80 bauds
* Plug-in units
* Optional in-built test equipment comprising:—
  a) Telegraph test set
  b) Level measuring set
  c) Frequency check unit
* Completely self contained with all power supplies
* Pilot facility 300 c/s or 3300 c/s

24 frequency modulated channels are provided in the nominal frequency band 420-3180 c/s with 120 c/s separation between adjacent channels. These are built up from 4 sub-groups of 6 channels each in the frequency band 1140-1740 c/s. Compactly assembled plug-in units use printed circuit wiring boards with small encapsulated filter and transformer units. Equipment is protected by bay covers, but test equipment and jackfields are directly accessible at centre of rack.

Bearer Band	300-3400 c/s
Deviation	± 30 c/s from mid frequency
Send level range	–15 to –35 dBm
Receive level range	–15 to –35 dBm
DC lines	Send 20mA double current. Receive up to 100 mA. Balanced loop and neutral loop conditions on request.
Temperature compensated	+ 5°C to + 55°C
Power supplies	100-120v or 200-240v AC (Battery operation through an inverter as optional extra).

Details of the latest AEI Carrier Telephone and Telegraph Equipment supplied on request



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Receive Unit and Send Unit

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Woolwich, London S.E.18, England

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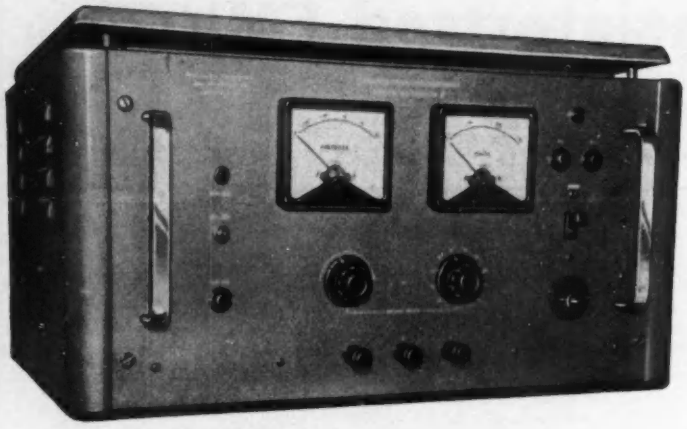
is the Keynote . . .



TRANSISTOR POWER SUPPLY
TYPE KTV/310

0 TO 30 VOLTS D.C.
AT 10 AMPS. FULLY REGULATED

Output resistance:	0.01 ohm.
Stabilisation:	1000 : 1
Ripple:	1mV. peak to peak
Mains Supply:	200/250 v. 50 c/s

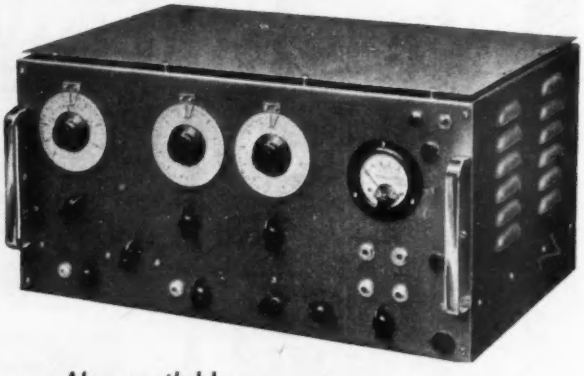
OVERLOAD CUT-OUT.

FULLY FLOATING OUTPUT TERMINALS.

SILICON AND GERMANIUM DEVICES USED THROUGHOUT.

OTHER TRANSISTOR POWER SUPPLIES AVAILABLE

PULSE GENERATOR
TYPE 302A
GENERAL PURPOSE
LABORATORY INSTRUMENT



½ amp. peak current available in output 0 to 100 volts continuously variable output. Fully Regulated Internal D.C. supplies. Rise Times of 0.015 μS. Low output impedance. Extremely small jitter.

SPECIFICATION:

Oscillator frequency:	10 c/s to 10 Mc/s.
Delay:	0.3μs. to 10 ms.
Pulse Width:	0.1μs. to 10 ms.
Pulse amplitude: (positive or negative)	0 to 30 volts into 75 ohms. 0 to 100 volts into 1,000 ohms.
Square waves:	10 c/s to 1 Mc/s.

The instrument can be synchronized or triggered from an external source.

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OSCILLOSCOPES
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SM

a unique source of INFORMATION on scientific instruments

There are two kinds of knowledge; knowing and 'knowing where to find out'. With science and technology developing so rapidly no one can hope to be fully informed on every worthwhile new technique or new equipment.

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(1) If you already know the answer to your problem but don't know who makes the most suitable equipment SIMA can tell you.

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(3) If you just have a problem, SIMA can often tell you whether someone has already found the answer to it and has developed equipment to meet it.

Where do SIMA get their information?

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ELECTRONIC & NUCLEONIC	MEDICAL & X-RAY
ENGINEERING & INDUSTRIAL	KINEMATOGRAPHIC
NAVIGATIONAL & SURVEY	PROCESS CONTROL & AUTOMATION

The Scientific Instrument Manufacturers' Association could be your most valuable source of such information and you will find them very helpful on *any* question about scientific instruments.

the SIMA enquiry service

Over 180 manufacturers with one address

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20, QUEEN ANNE STREET, LONDON, W.1.

Telephones—Secretariat Langham 4251 Enquiry Service Imperial 6000

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TRUE R.M.S. VALVE VOLTMETER
TYPE 612

For the measurement of true r.m.s. values of complex voltage waveforms from 300 μV to 300V, for full-scale meter deflection at frequencies between 5 c/s and 500 kc/s

- ★ **Measures true r.m.s. voltage independent of the waveform.**
- ★ **Wide voltage range in 13 steps.**
- ★ **High input impedance.**
- ★ **Auxiliary decibel scale.**
- ★ **Mains-operated and portable.**
- ★ **High thermal and electrical stability.**
- ★ **Independent of mains variations.**

Voltage Range:
Thirteen voltage ranges are provided covering full-scale meter deflections from 300μV to 300V.

Accuracy:
Amplifier response does not vary more than ±3% from 15 c/s to 150 kc/s, and ±5% from 5 c/s to 500 kc/s for sine waves.

For complex waves, amplifier response does not vary more than ±3% for all component frequencies from 15 c/s to 150 kc/s, and ±5% from 5 c/s to 500 kc/s, and peak to r.m.s. ratios not greater than 5 at full-scale deflection or correspondingly greater ratios at smaller meter readings.

Uniform accuracy of 1% of scale-reading obtained with logarithmic-scale calibration.

APPLICATION :

Unlike most valve voltmeters which are average or peak-reading instruments calibrated to read r.m.s. values, the Type 612 true r.m.s. valve voltmeter also measures accurately the effective value of waveforms other than sinusoidal.

It is essential for measuring voltages and currents associated with saturated reactors, rectifier ripple, noise generated in transistors, valves, and resistors, acoustic and vibration tests, and intermodulation and harmonic distortion determinations.

THE DAWE RANGE OF VALVE VOLTMETERS INCLUDES:-

TYPE 613C : An electronic valve voltmeter for voltage measurement between 250μV and 300V over a frequency range of 10 c/s to 2 mc/s. It can also be used as a high gain wideband amplifier.

TYPE 614C : An extremely compact and portable sensitive electronic valve voltmeter designed for the measurement of voltages from 80μV to 300V at frequencies between 5 c/s and 100 kc/s.

Technical data forwarded on request: DAWE INSTRUMENTS LTD., HARLEQUIN AVE., GREAT WEST RD., BRENTFORD, MIDDX. : ISLeworth 7331/5

A member of the Solartron group of companies

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PRECISE RESETABILITY
LAW ACCURACY ± 1.0% ABSOLUTE
or 0.25% IF REQUIRED

This ¼" diameter Helical of high quality yet inexpensive has been designed for manual operation and is available in two versions

1. **For standard wiring**
2. **For PRINTED CIRCUIT application using the accepted 0.1" grid.**

HELICALS BY RELIANCE

10-TURN MINIATURE

TYPE HEL 07-10

SPECIFICATION

Resistance Range	**100-30,000 ohms**
Resistance Tolerance	**±5%**
Law Accuracy (Absolute)	**±1.0% or better to within 0.25% if required**

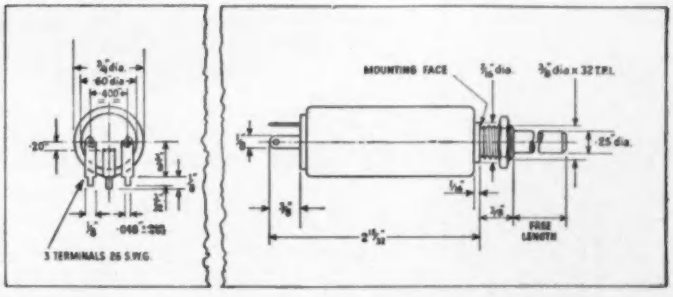
Independent Law Accuracy to closer Limits
Rotation—effective angle 3600° +10° −0°
Dials available if required

Send today for Data Sheets 11 and 12 which give full technical details and dimensions

For SERVO application an entirely new Low Inertia multi-turn Syncro size unit is available

See below ★

DIMENSION DRAWINGS OF PRINTED CIRCUIT & STANDARD VERSIONS HEL 07-PC10 & HEL 07-10



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with servo systems, function generation and environment simulation, Reliance by means of an entirely new technique (covered by world wide patents) have developed and offer a multi-turn Potentiometer embodying in a single unit the following outstanding advantages:

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Low Inertia <0.05 gm. cm²
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GD 767

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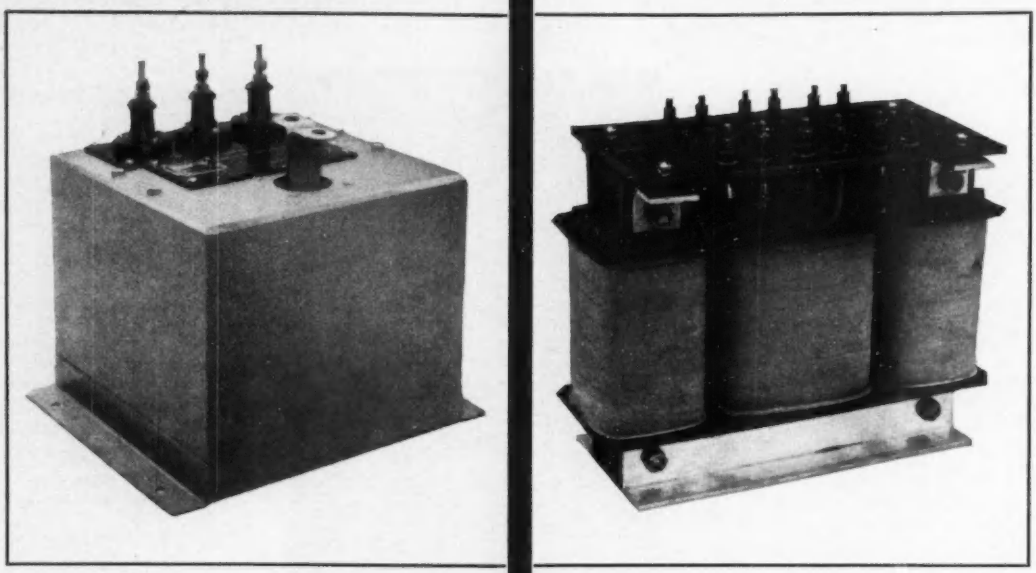

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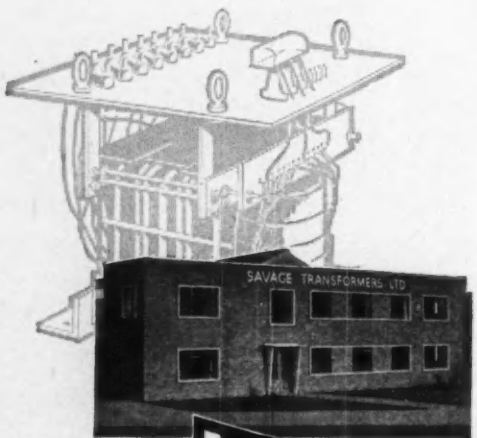

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Left — a push pull, class B output transformer designed to deliver 2500 watts into a very low impedance transducer, at from 10 K/c to 100 K/c.

Right — one of a large family of Saturable Reactors, used to control the current delivered by the supply mains to a heating load.

Maybe our experience could provide the answer to your problem — We should be happy to co-operate in its solution.

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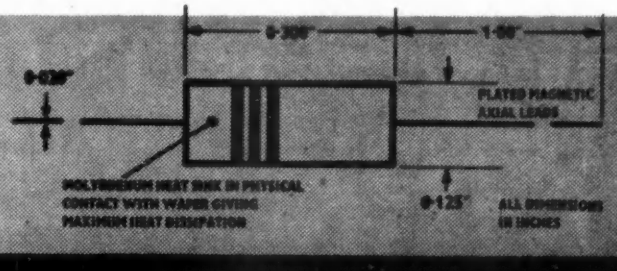

CV Type Approval covers many of these devices—write for details

Data Sheets and Application Information are available on all TEXAS semiconductor devices.

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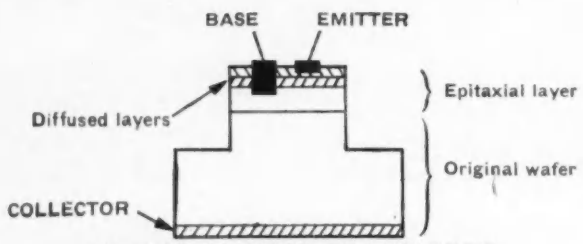
INDUSTRY'S FASTEST NOW IN QUANTITY

f_T = 300 Mc/s (Typical)

2S131

THE MOST SIGNIFICANT DEVELOPMENT SINCE TEXAS INSTRUMENTS INTRODUCED THE FIRST COMMERCIALLY AVAILABLE SILICON TRANSISTOR



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The epitaxial process consists of the carefully controlled growth by vapour deposition of an extremely thin layer of high resistivity single crystal semiconductor material upon a wafer of low resistivity. Base and emitter regions are formed in the epitaxial layer by the diffusion of two more thin layers.

The transistor action is confined to the three upper layers, the original low resistivity wafer serving only as a platform for ease of fabrication.

Low Saturation Voltage (1 volt max. at 100 mA) *virtually insensitive to temperature.*

The Texas Instruments 2S131 silicon epitaxial transistor combines for the first time in a single device the desirable characteristics of:—

- A low saturation ("bottoming") voltage, typically 0·27V at 10 mA and 0·8V at 100 mA.
- A high f_T, typically 300 Mc/s.
- A total switching time of 33 nanoseconds.
- Thus, this single transistor is ideally suited for fast computer logic circuits, r.f. and i.f. amplifiers and low power output stages.
- These new transistors are AVAILABLE NOW.

SILICON TRANSISTOR PRODUCTION

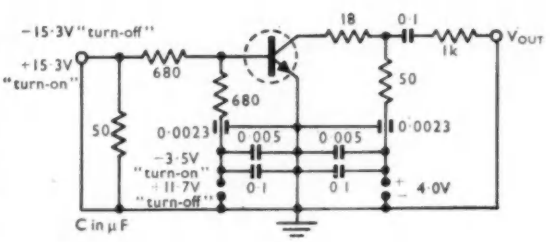
$V_{CE(sat)}$ at 100 mA = 1 V max.

SILICON NPN

EPITAXIAL

MESA TRANSISTOR

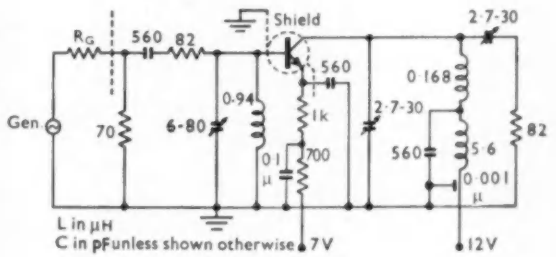
AS A HIGH-SPEED SWITCH



Typical Performance

turn-on = 8 nsec
turn-off = 25 nsec
33 nsec

AS A 60 Mc/s I.F. AMPLIFIER



Typical Performance

17 dB per stage power gain

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Inching, load locking, shaft positioning, high-speed motor reversal, speed synchronising—there's no end to its applications!

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For full operating data, technical information and physical details of CROFTS instrument clutches—send for Publication 6013A.

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the BYZ14 rugged and reliable

SILICON POWER RECTIFIER

The Mullard BYZ14 — is a new 20 amp, 200 volt silicon power rectifier, rugged for industrial conditions. In addition it has built-in safety margins which are more than adequate as you can see for yourself from the data below. Truly the BYZ14 is a rectifier which every power engineer will immediately recognise as being specifically designed for Heavy Engineering and Industrial applications.
The BYZ14 can be used as a simple power rectifier for the numerous applications where a low voltage d.c. is required or it can form the basic building block for large megawatt cubicles. It is particularly suitable for use with silicon controlled rectifiers.
The BYZ14 offers all the advantages of compact strength and rugged reliability at a price which is comparable to that of ordinary 20 amp, 200 volt devices.
This new rectifier gives the Designer a device which is more than sufficient for the applications for which it is intended and thus opens up a whole new concept of rectifiers for industrial usage. When writing for full data please quote reference number, D346.

Mullard

semiconductors for industry

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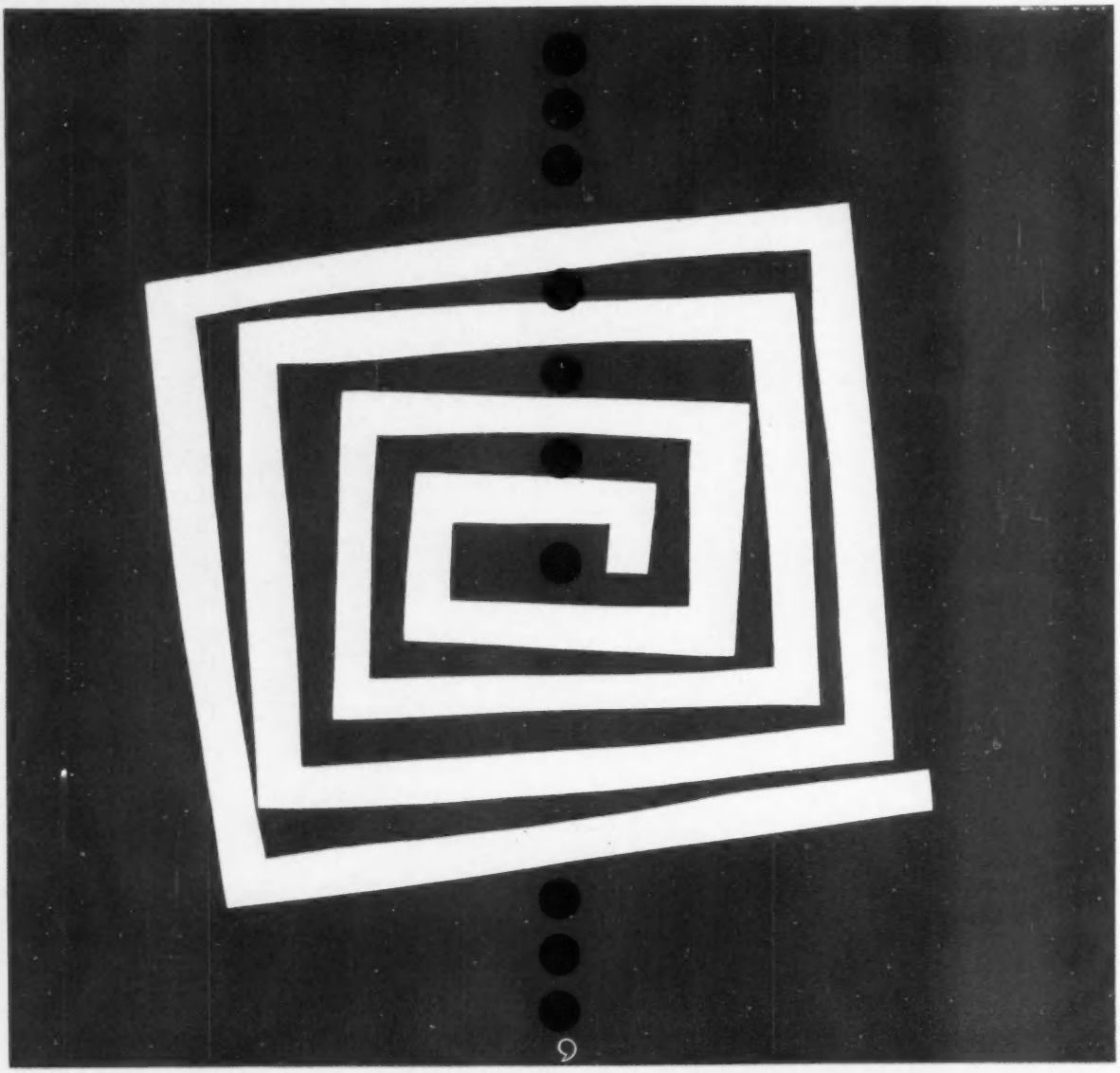
ABRIDGED DATA

Absolute Maximum Ratings (limiting values)

Maximum recurrent P.I.V.	400V
Maximum transient peak voltage	400V
Maximum surge peak voltage (max. duration = 10 ms)	400V
Minimum breakdown voltage	800V
Maximum average forward current	20A
Maximum recurrent peak current	100A
Maximum surge current	900A
Maximum junction temperature	180°C

MIS 34

EE 34 167 *for further details*



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. . . the pattern of glass usage in the electronics industry . . . how many different kinds of glass are used . . . what it is mostly used for . . . or all the possible applications you have for it. But we do know how to make the finest glass available, whatever your needs. If these are for optical or other technical glasses, we're experienced enough to know the right answers, and would like to hear from you.

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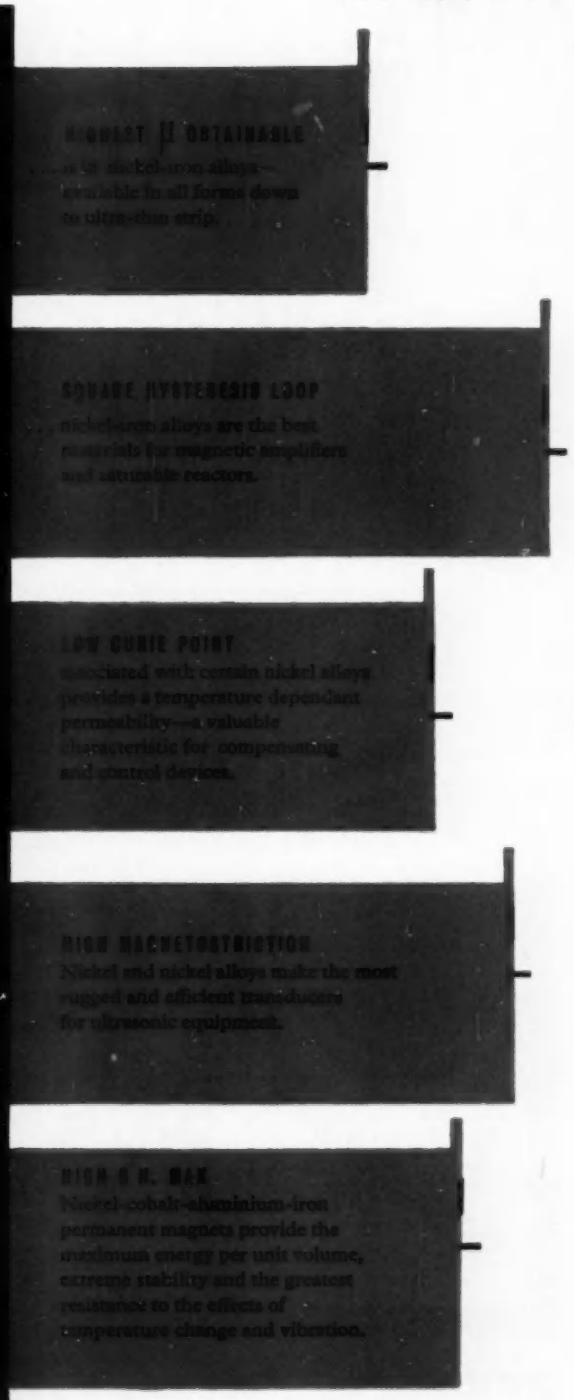

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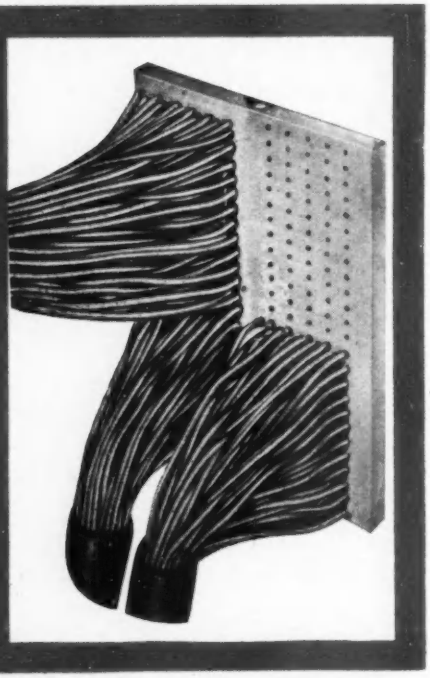

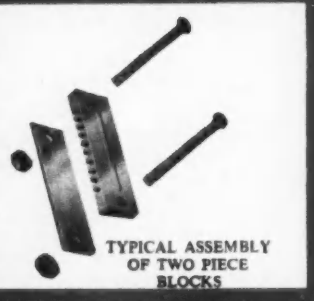

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HR (Heat Resistant) Plugs are the new MS style series specifically designed for high temperature applications. Two versions—one for continuous duty in temperatures up to 1000°F., the other up to 650°F. at lower cost. Ball cone seals on mating surfaces make them moisture-proof. Available in a wide range of MS-type shell styles and sizes which can mate with standard MS connectors.

Write for HR catalogue for full technical details

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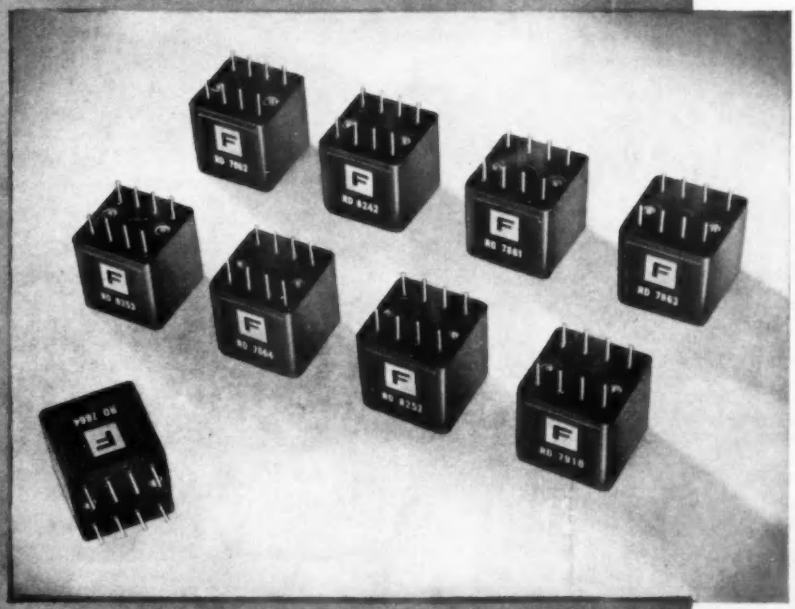
Ferranti Ltd. have introduced a range of subminiature transformers and chokes to satisfy the increasing demand for components manufactured to the same high standards as those handling much greater powers. The coil/core assembly is encased in an epoxy resin to give maximum mechanical and climatic protection and thus the component is capable of withstanding the high mechanical stresses associated with military applications.

The "Submin" range is based on Inter-Service Standard laminations, and with a combination of lamination size and stack ratio, a total of nine distinct sizes is available. Because of the extensive use of printed wiring techniques the terminals and fixings have been designed to conform to the standard 0.1" matrix.



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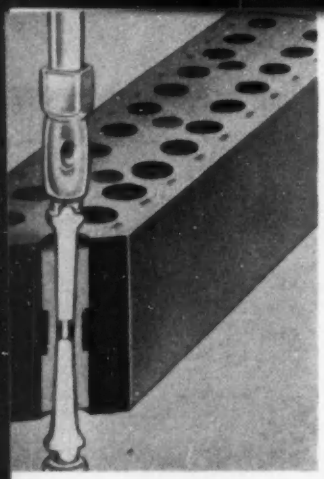

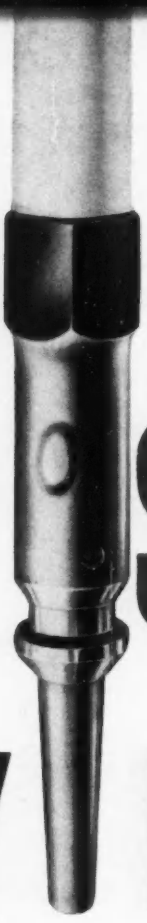

STAPINS STAY PUT

STAPIN *solderless solid shank taper pin connections maintain electrical stability under conditions of excessive vibration, violent shock and repeated rough handling.*

CRIMPED Tool-controlled crimping connects the Stapin to the wire and eliminates soldering.

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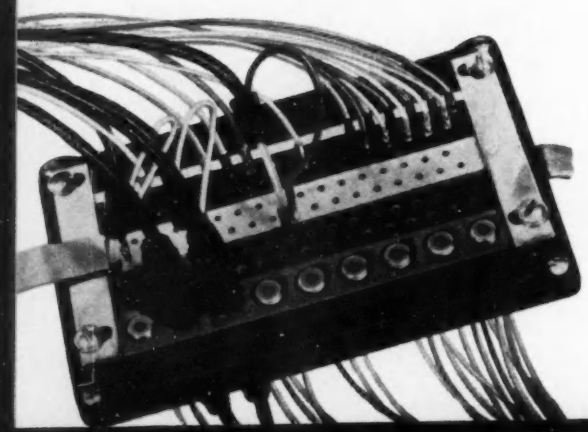
For technical data and full details of the Stapin range write for literature or ask our representative to call.



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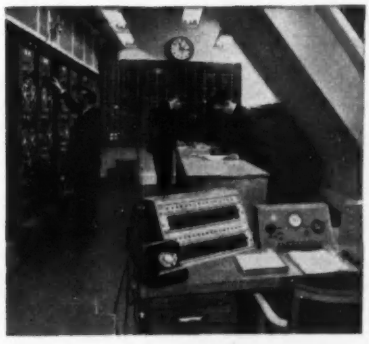
The Radiophonics people make their effects from 'white noise'—every frequency from zero to infinity sounded simultaneously. Emitape records it unflinchingly, and it is finally edited to produce the desired result. Frequencies are flattened, sharpened, added, removed. Emitape thrives on it all to make effects as far removed from the galloping coconuts era as the Comet from Bleriot.



The BBC rely on Emitape for the great majority of their recordings. Standards must be high. One fault could mean dozens of complaints.

Emitape

–used by the BBC 9 times out of 10

ET13

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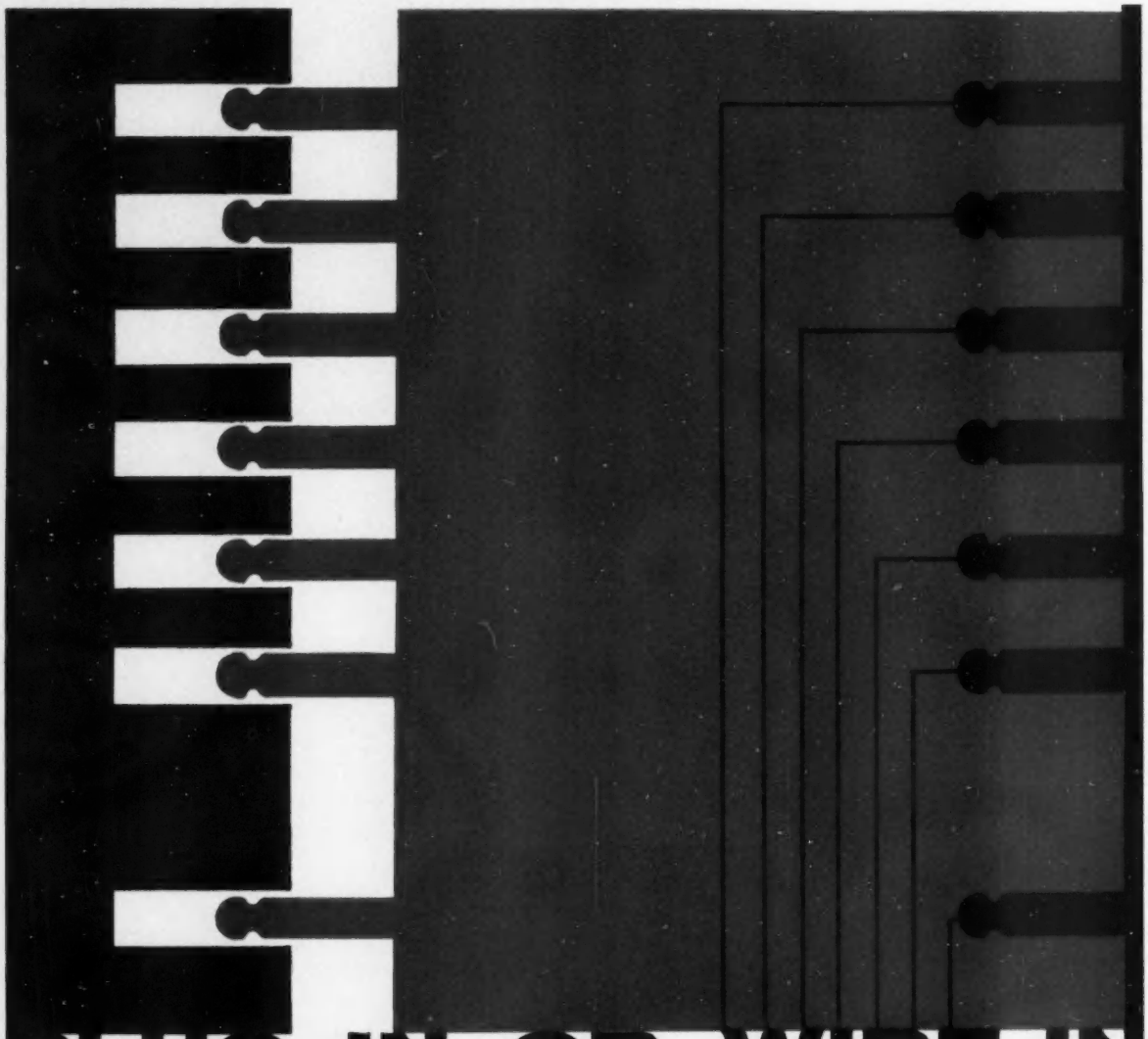
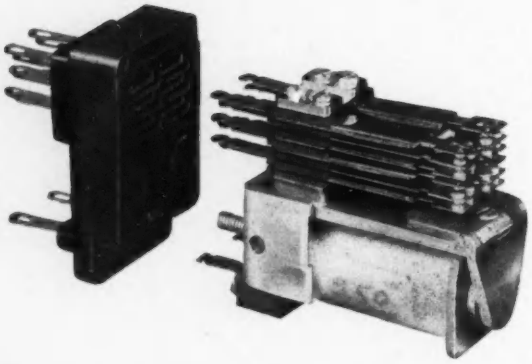


PLUG-IN OR WIRE-IN



Plug-in or wire-in, this is the choice—a difficult choice which frequently faces the equipment designer.

Although it is generally agreed that for the introduction of components into a circuit the most reliable method is to wire in, quite frequently conditions arise where the choice must be in favour of plugged-in components.

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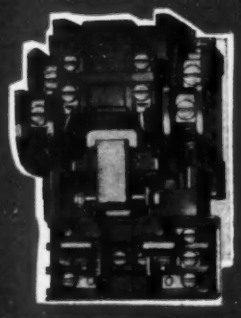

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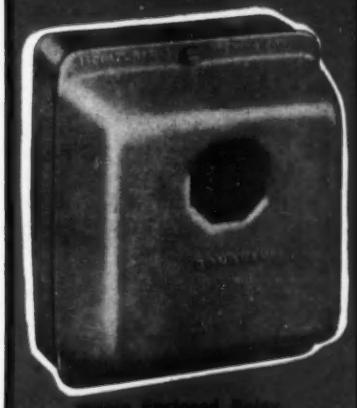

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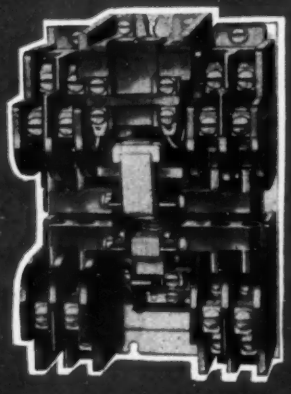

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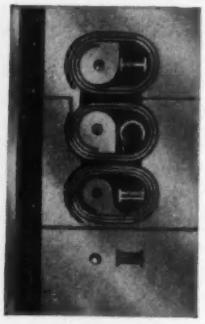

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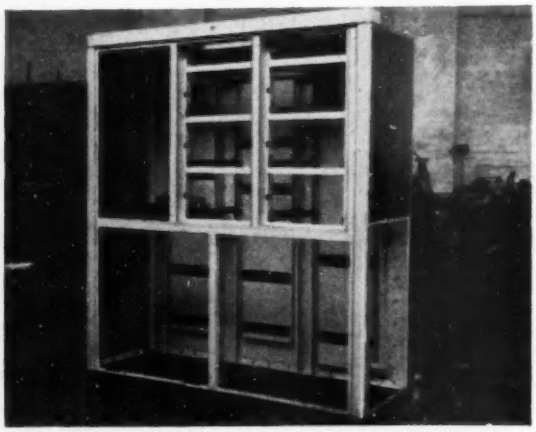

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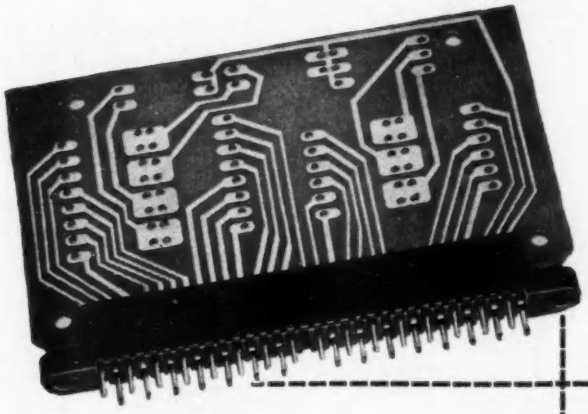

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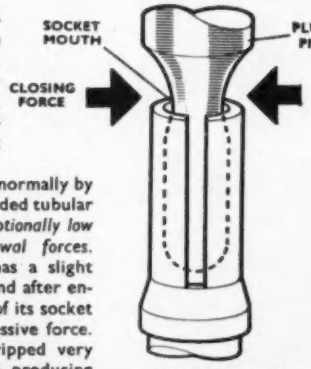

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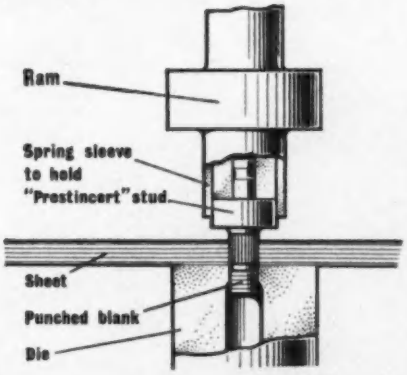

The illustration shows a "Prestincert" terminal stud being pressed into a sheet of material. The leading face has just punched the sheet, and the knurled stem is cutting its way into the hole where it is keyed against rotation; in the final stage it will be peened over the underside of the sheet, preventing withdrawal.

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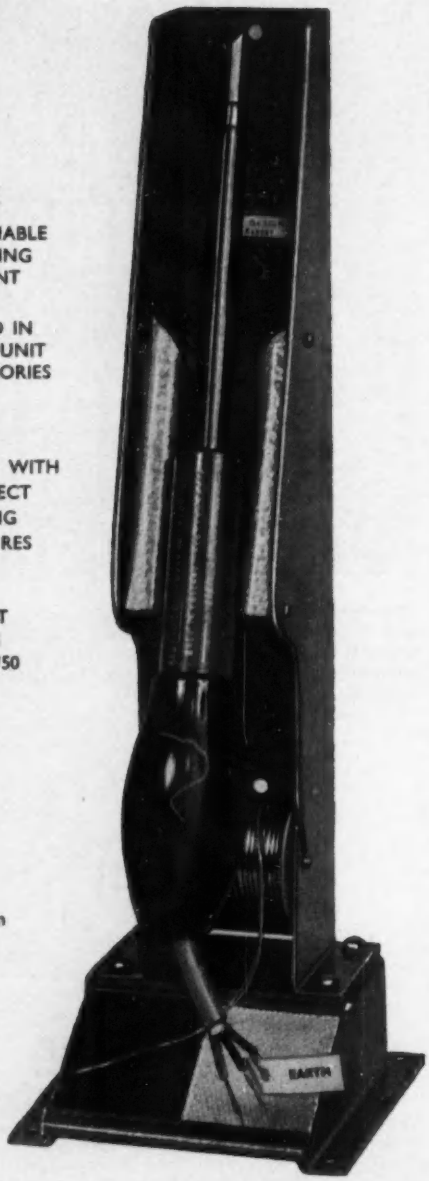

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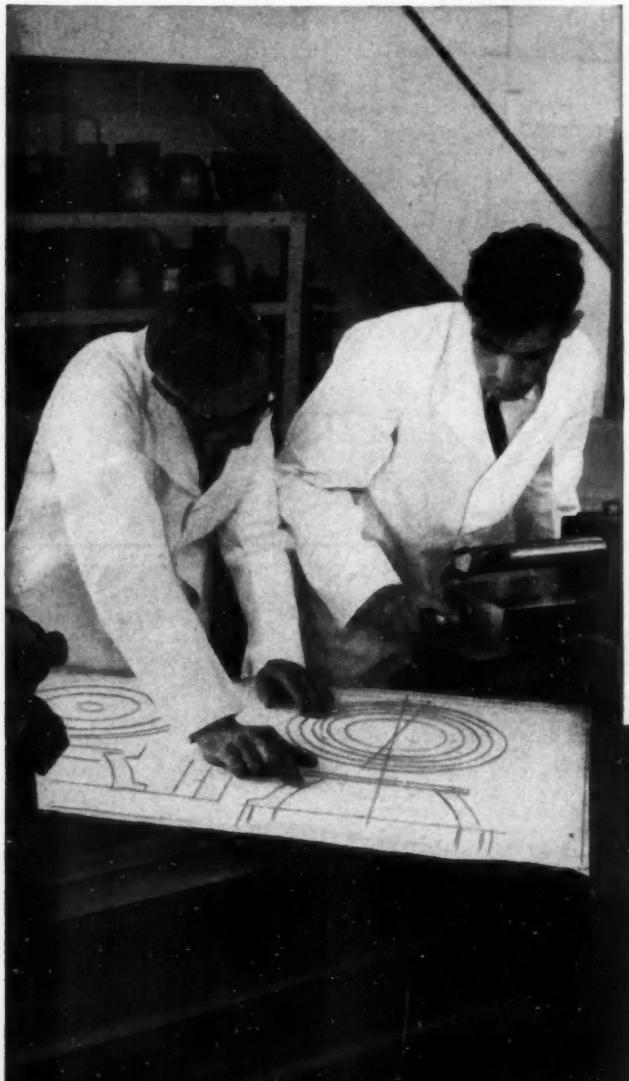

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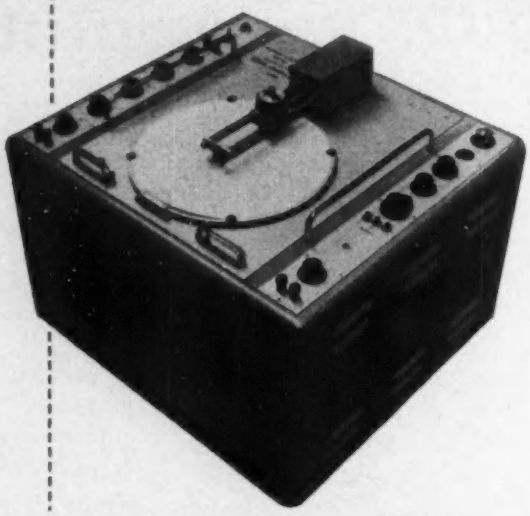

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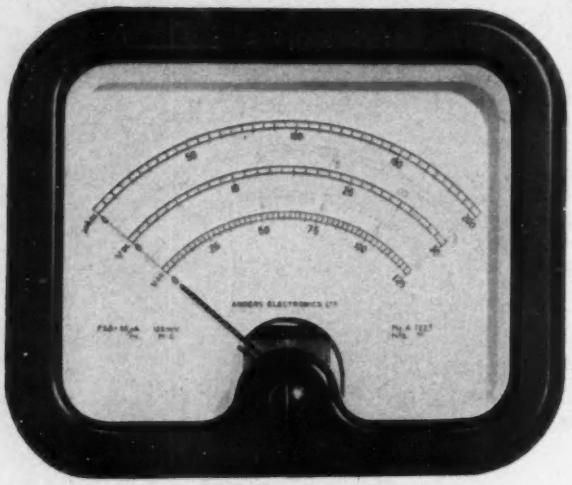

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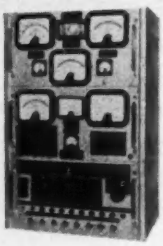

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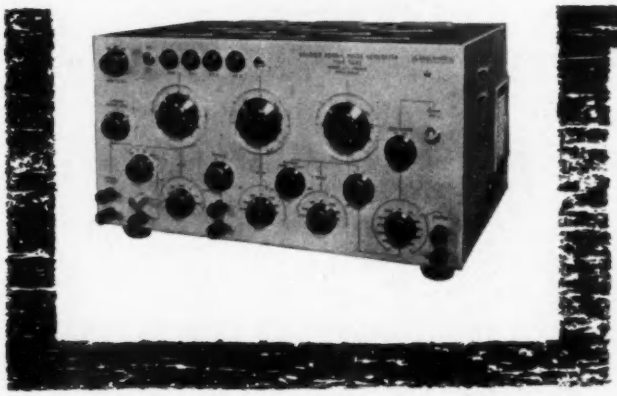

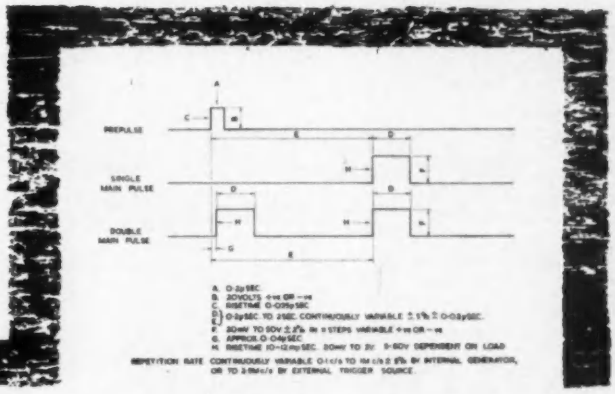

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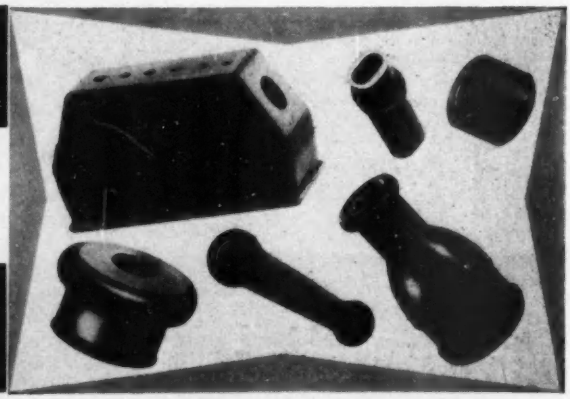

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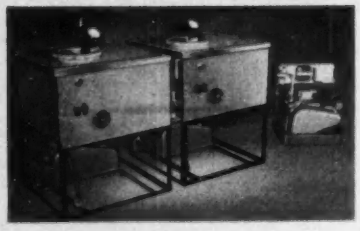

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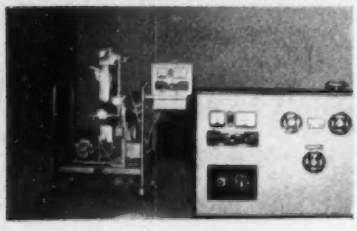

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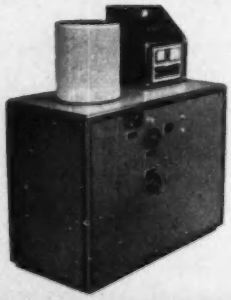

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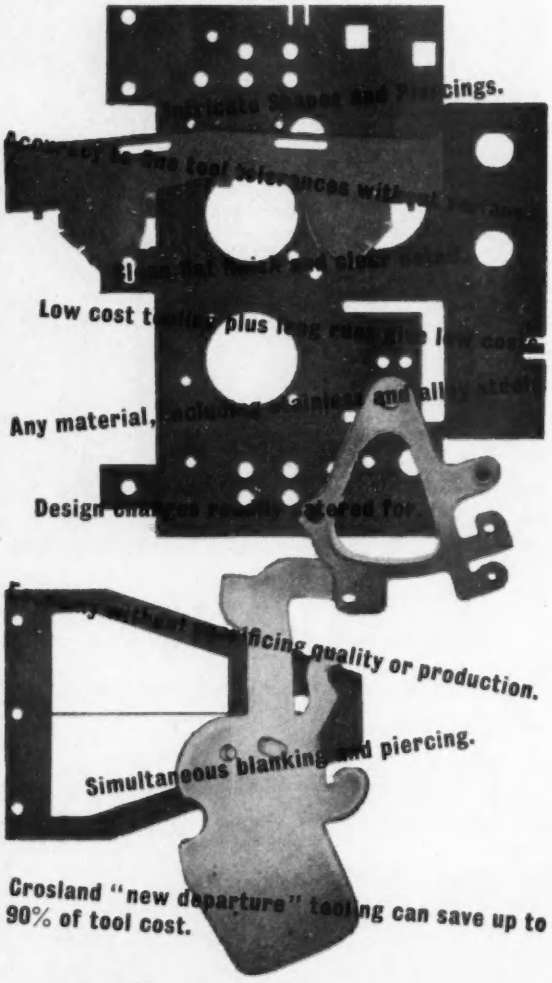

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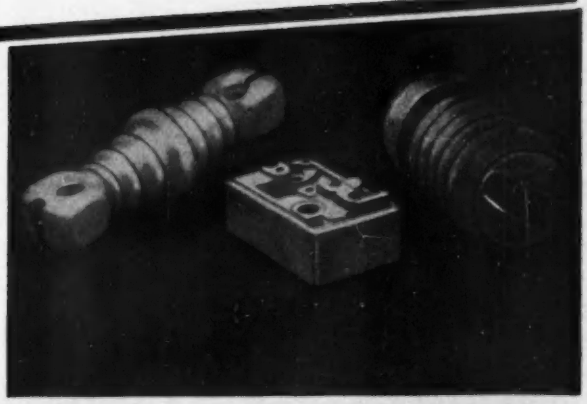

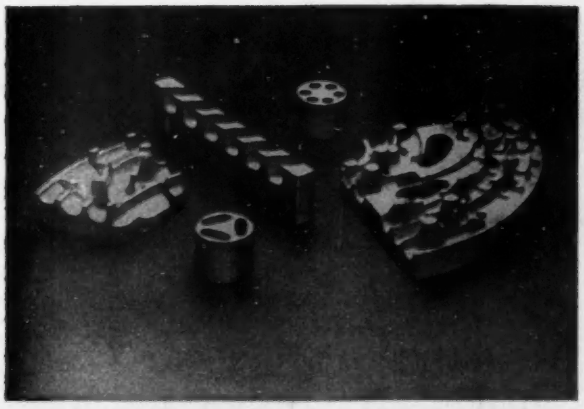

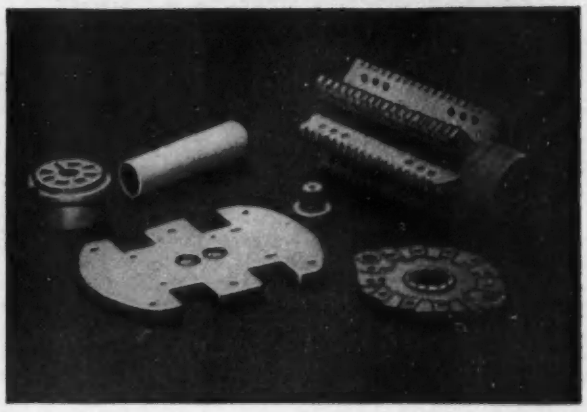

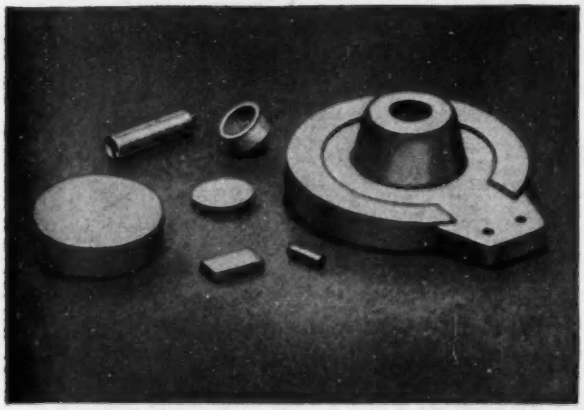

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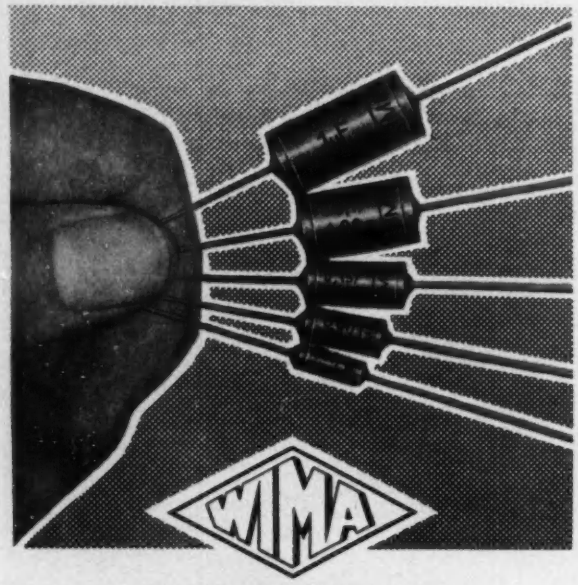

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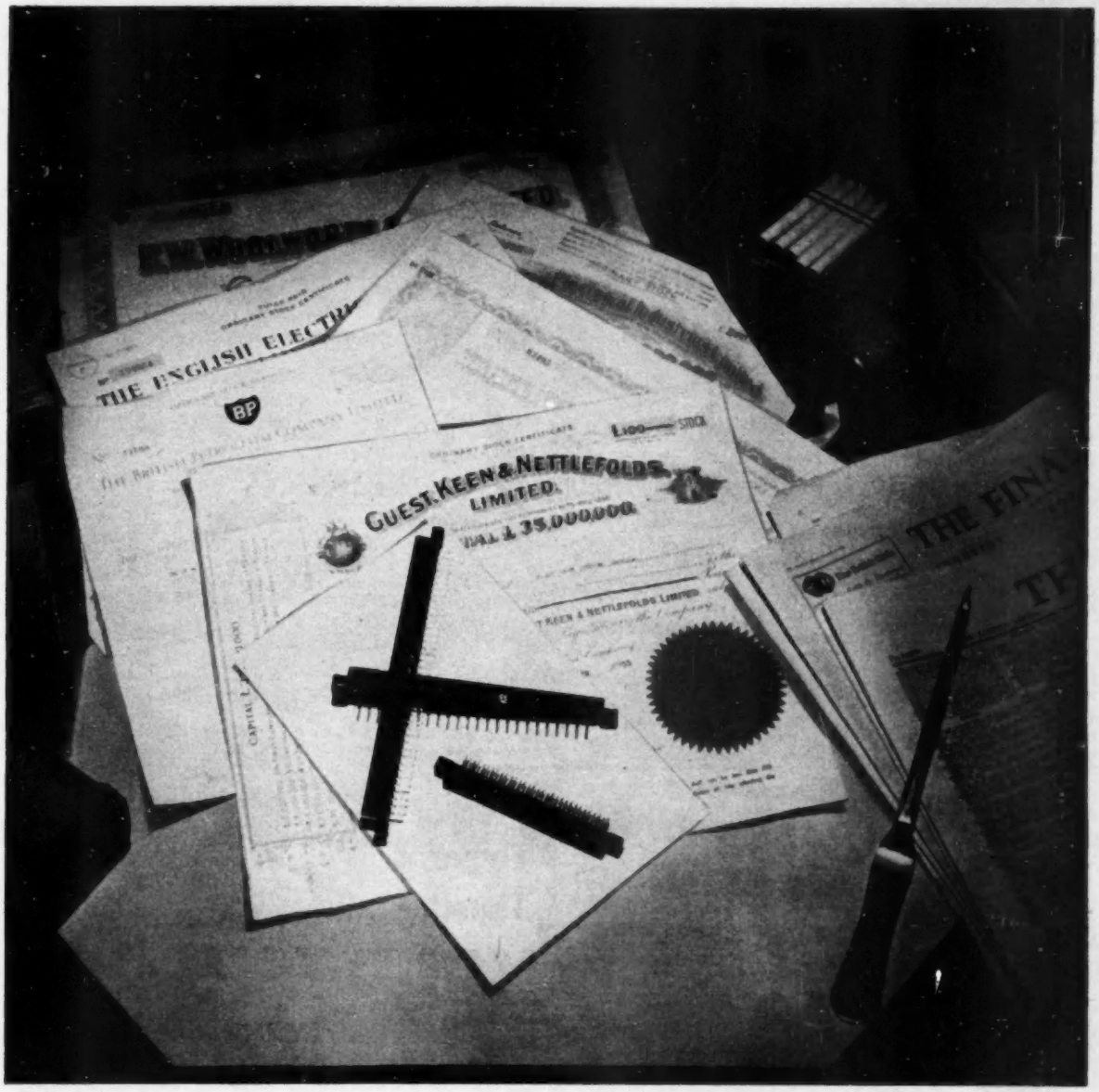

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0.150	0.062	8, 16, 24, 32 & 40	0.200	0.062	16, 32, 48 & 64
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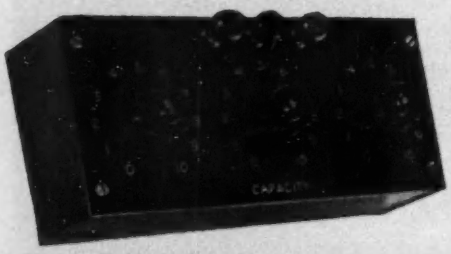

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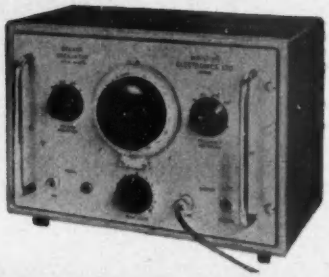

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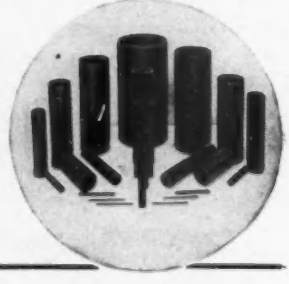

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STABILITY AND RESETTING ACCURACY: stability for mains variations of ±10% is ±0.05%. Drift due to all other causes is within the following limits for the periods stated: 1 hour ±0.05%, 100 hours ±0.1%, 1,000 hours ±0.2%.
A standby switch is provided and when the unit is switched on after a stand-by period any given voltage will be within ± 0.05% of its previous figure.
RIPPLE AND PULSE CONTENT: ripple, noise and spurious pulses have a maximum level of 500 microvolts at 3,300 volts H.T. at the low-impedance output. At the high-impedance output this is reduced to below 100 micro-volts.

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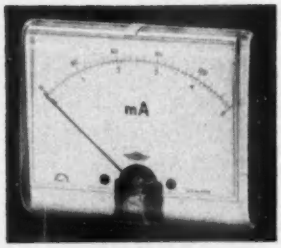

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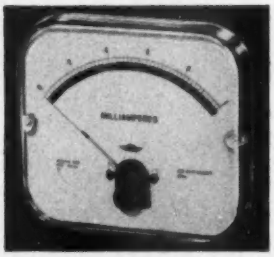

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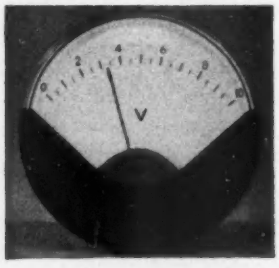

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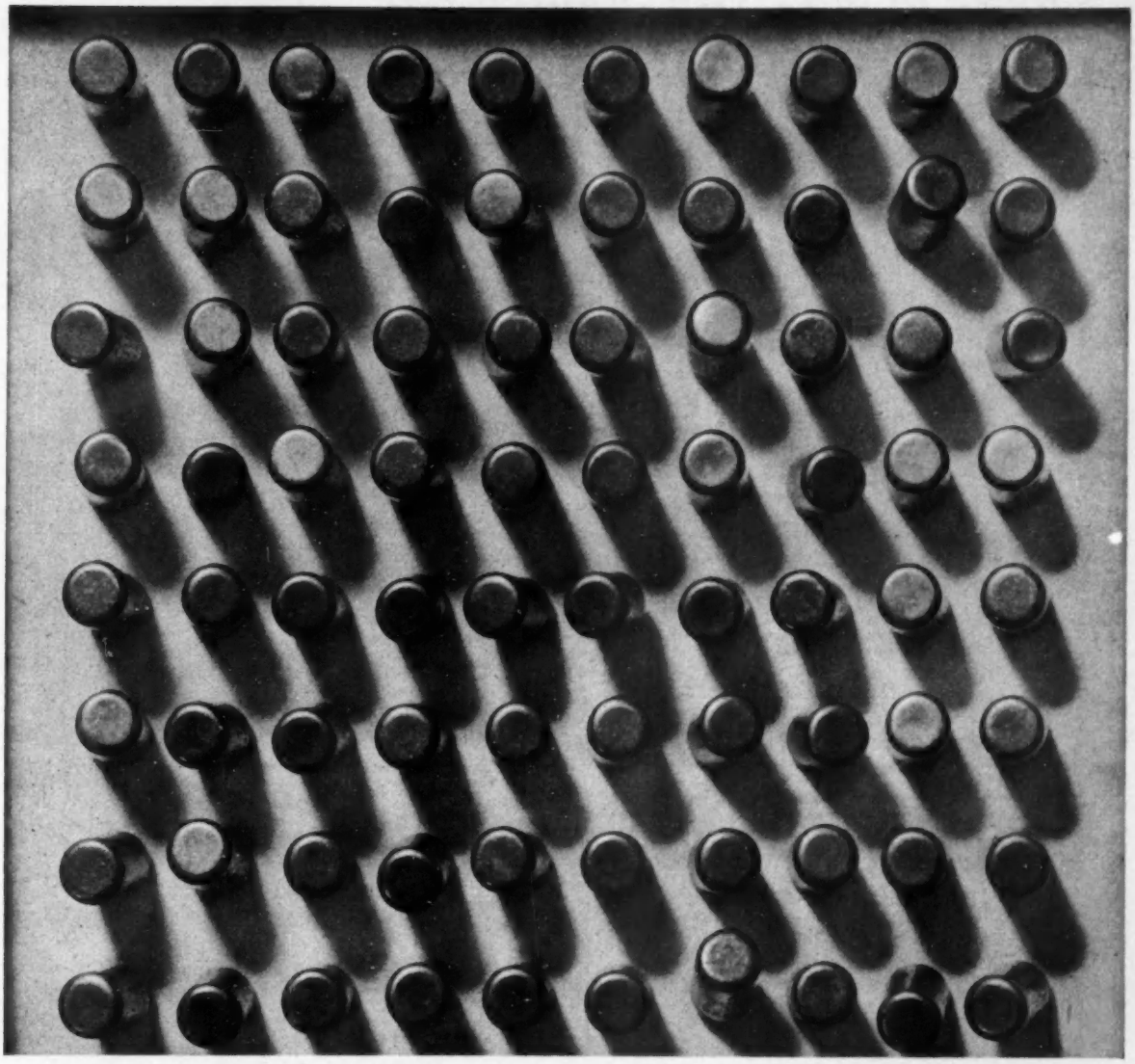

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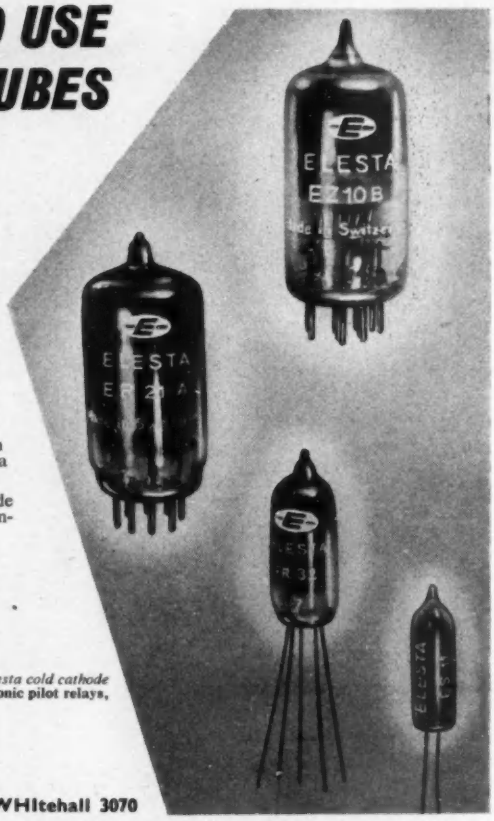

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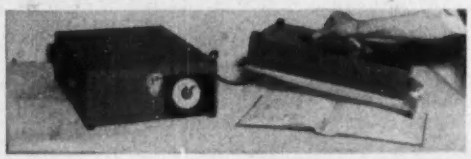

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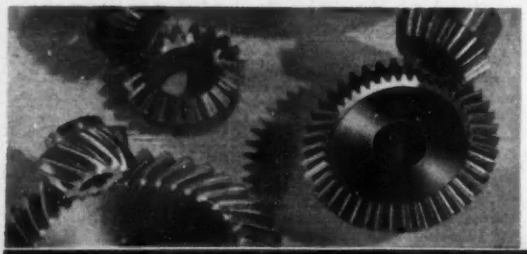

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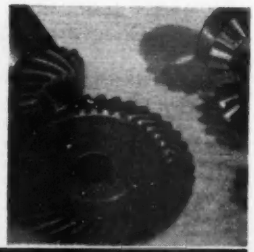

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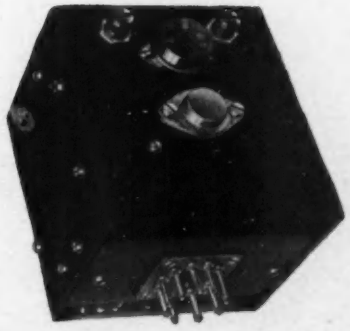

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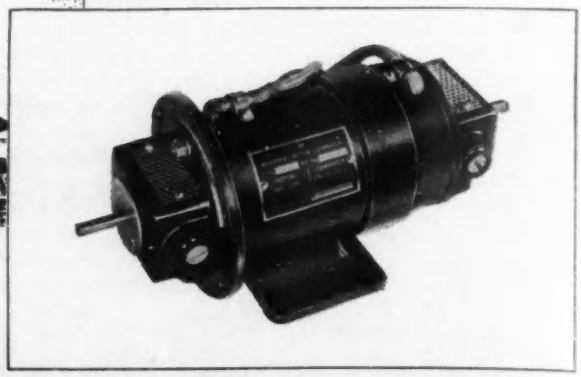

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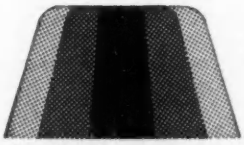

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Built-in Tone Generator (B.F.O.) for selective measurements with provision for external level control. The B.F.O. can be offset from the Analyser tuning frequency by 0 to 16 kc/s for intermodulation measurements.

Frequency Response Recorder: The Analyser can be connected and mechanically coupled to the Recorder, Type NS3, which uses paper charts 20 cms long graduated directly in frequency and amplitude. Complete frequency response recordings can be made in 130 secs.

Frequency Dial: 0 – 16 kc/s with linear calibration up to 100 c/s for high resolution at low frequencies, logarithmic from 100 c/s to 2 kc/s and linear from 2 kc/s to 16 kc/s. Accuracy 0·5% + 1 c/s.

Incremental Dial: From 0 to ±60 c/s, direct reading.

Distortion and Residual Modulation products more than 75 db down (typically 80 db).

Sharp Cut-Off on all Bandwidths. Response more than 60 db down at ±40 c/s in "2 c/s" position.

15 Ranges from 100 Microvolts to 1000 Volts f.s.d. Hum and noise less than 2 microvolts, lowest detectable signal 3 microvolts. Input impedance 2 megohms on all ranges.

This Wave Analyser is also available without Tone Generator, the type number is then FRA2.

Write for complete information

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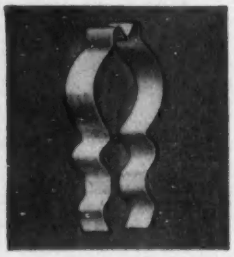
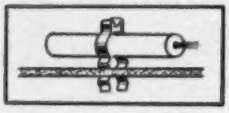
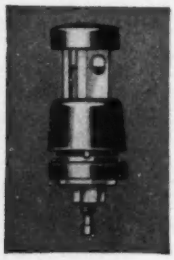


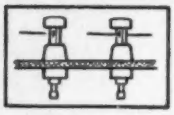
Top illustration shows the clip greatly enlarged whilst the lower picture shows the clip actual size and also the method of fixing.

TRANSISTOR CLIPS
in Beryllium Copper

(Patent and Type Approval applied for)

Of compact design, and taking up no more room than the Transistor itself, these Clips, manufactured from Beryllium Copper and formed so as to assist heat dissipation, are designed to suit cylindrical Transistors such as the Mullard OC.72 for fixing horizontally to printed circuit boards.





Pressure on the terminal cap opens the transverse hole and allows the wire or pin to be inserted. Release pressure and wire or pin is firmly held in position.

SPRING LOADED WIRING TERMINAL

Designed for mounting on panels up to $\frac{1}{8}$" thick, the terminal accepts wire ends or pins up to $\frac{1}{8}$" diameter and provides a quick and simple connection, secure and proof against vibration. Terminals are available from stock with Black or Red Thermo-plastic fittings or other colours to order.

Ratings :—Current 5 amp. Test Voltage 1000 V., with contact resistance. (Patent and Type Approval applied for).

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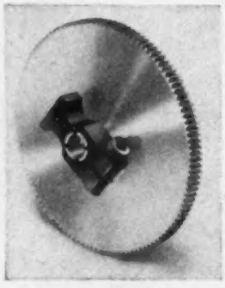
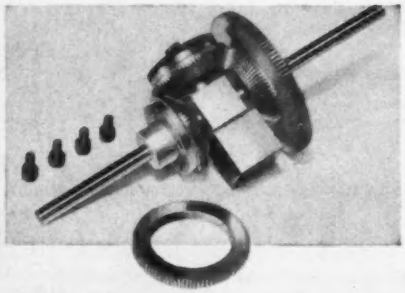


reduce eccentricity with split-hub gears



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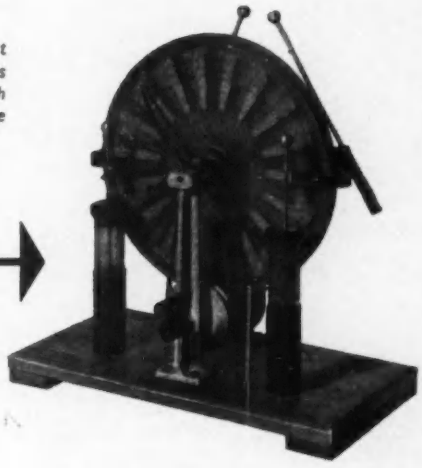

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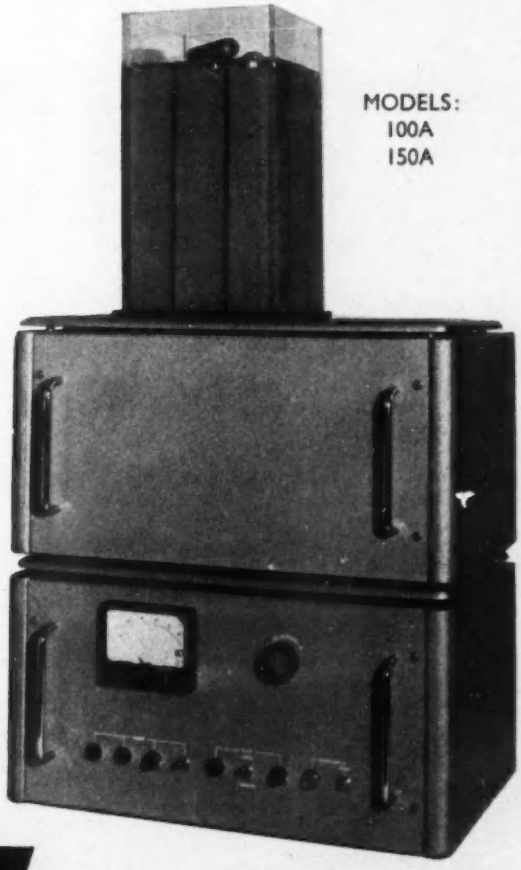
150A



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Output DC Current	: 0-100 mA shared between sockets
Output DC Voltages	: 150v 200v 250
Regulation	: 0·15% 0·025% 0·025%
Voltage stabilization Ratio	: 0·1/5 0·075/5 0·075/5
Ripple	: Less than 0·4mv RMS on full load
AC Output	: 6·3V, 2A at each socket
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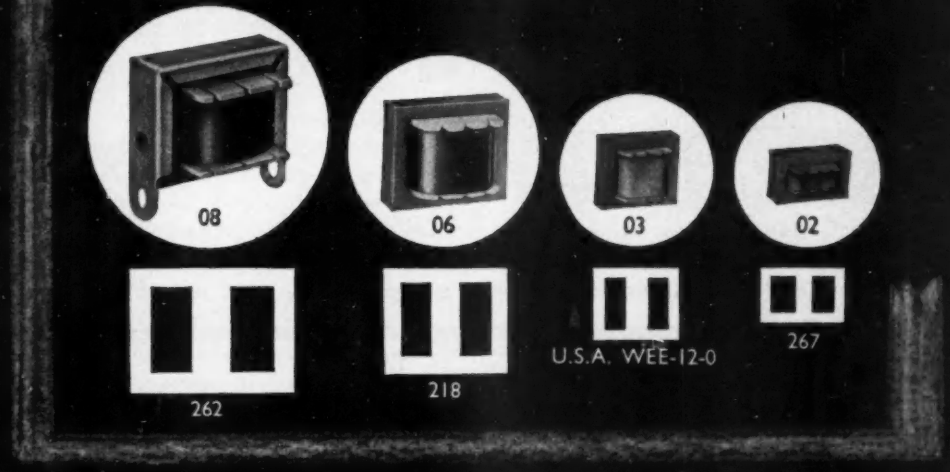

Transformers and Laminations shown actual size

In our latest additions to our transformer range we have concentrated on adopting an international standard which offers the maximum economy in material usage, consistent with minimum possible dimensions. In our new 03 size, for example, which is interchangeable with American and other standards, we have designed the lamination tool to be nearly scrapless and the increased window size makes it possible to use wire of greater thickness with corresponding advantage in both cost and reliability.

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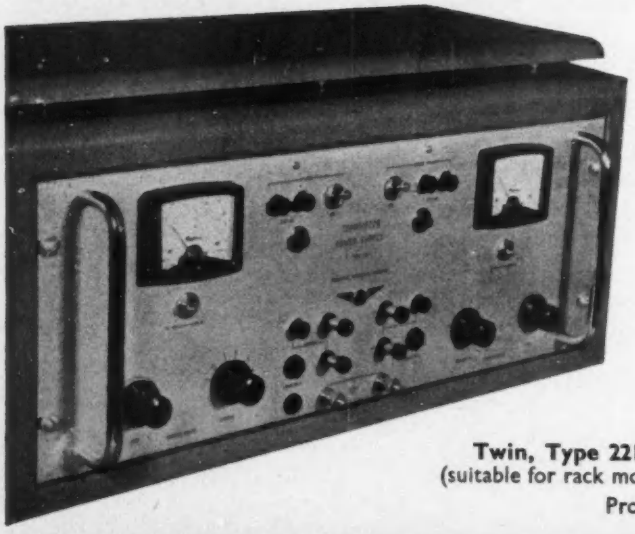

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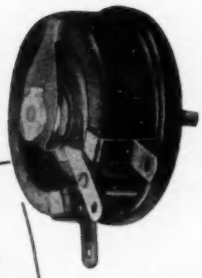

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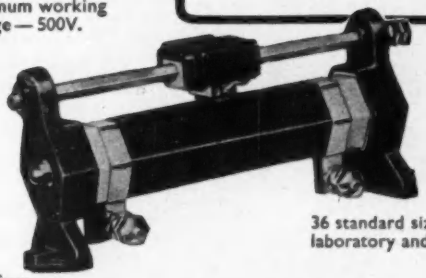

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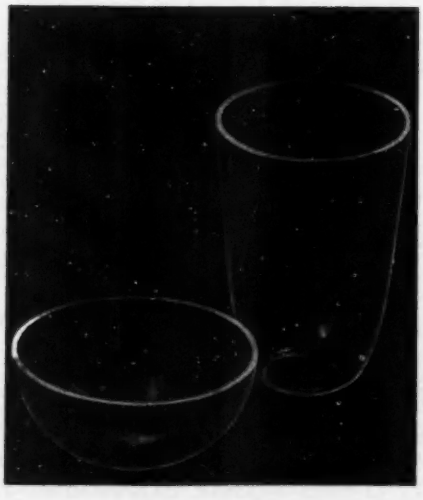

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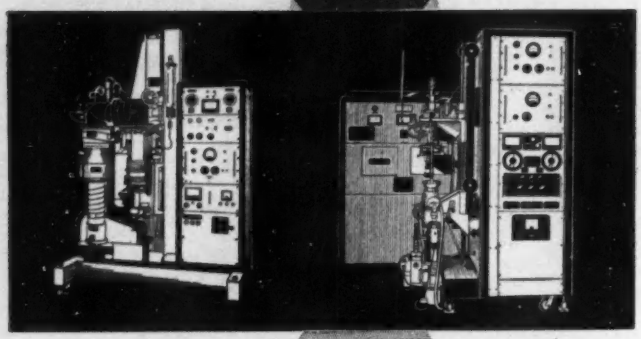

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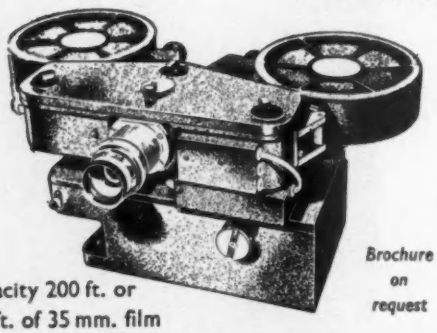

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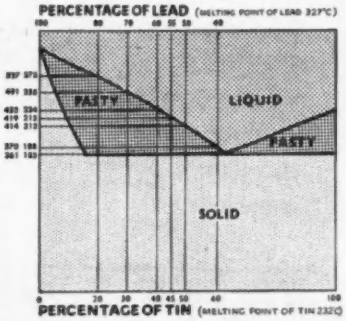

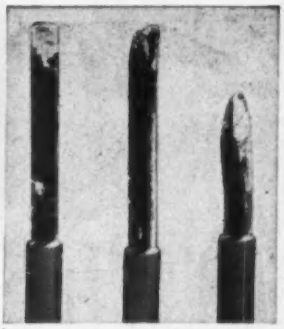

(left) after 10,000 joints with Savbit. (centre & right) after 1,000 and 7,500 joints respectively with standard tin/lead alloy.

PRINTED CIRCUITS

Leaflet P.C.L. 101 gives full details of a complete soldering process developed by Multicore Laboratories for printed circuits.

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Made under sole British Licence of Patent No. 721,881.

Savbit Type 1 alloy was developed after extensive research in the Multicore Laboratories into the main causes of bit wear. It incorporates a small percentage of copper which prevents absorption of copper from the bit into the solder alloy. After prolonged tests, it was found that the life of solder bits was increased by up to 10 times. The speed of soldering is not affected.

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PUBLICATIONS

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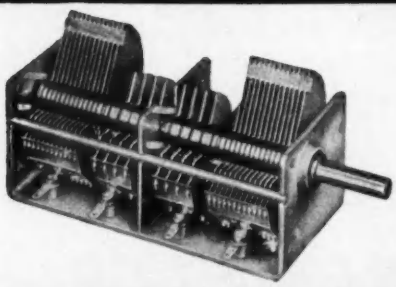

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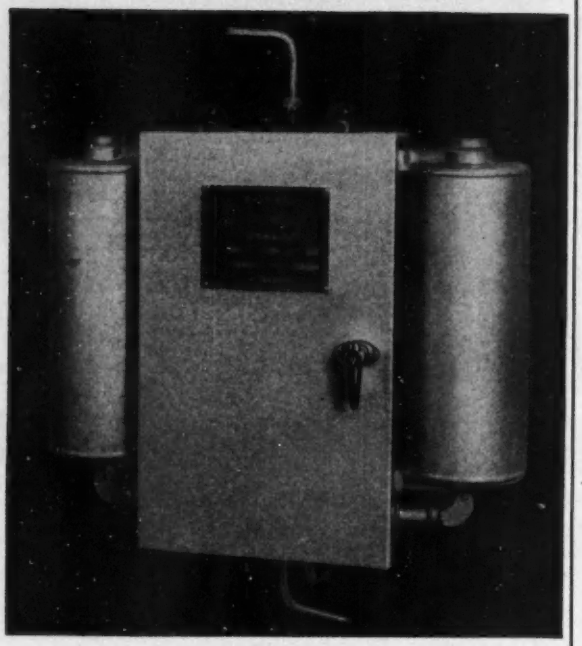

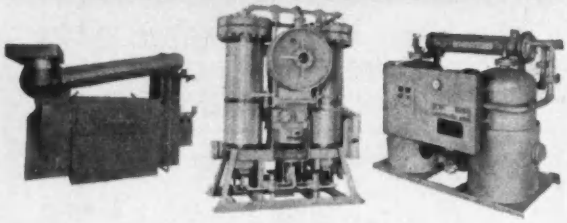

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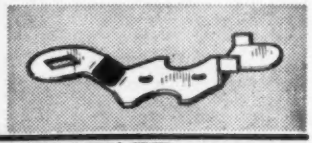

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IF IT

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COMPANY LIMITED
MILLTOWN ST., RADCLIFFE
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TELEPHONE: RADCLIFFE 2675

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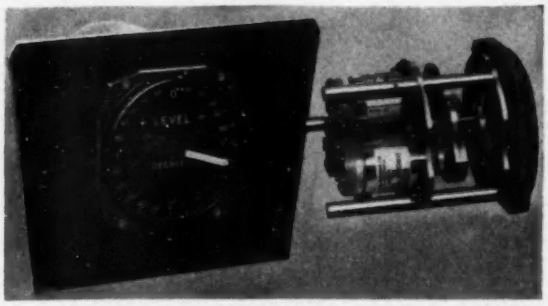

Servo indicator manufactured for Weapons Division, A. V. Roe & Co. Ltd., in connection with a remote indicating level, sensitivity ± one minute of arc. Indicator is also fitted with a repeater synchro to drive a pen recorder.

MODULAR SERVO GEAR BOXES

Complete mechanisms can be produced to specific requirements from standard components. Readily interchangeable gear ratios and components bring HIGHLY COMPETITIVE PRICES and quick delivery. Suitable for experimental prototype and production quantities. Gears to Admiralty Class 1, zero backlash in all ratios using spring loaded split gears corrosion resistant throughout, ball bearings friction tested, assembly work carried out in dust-free conditions.

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...SINGLE COMPONENT AERIAL ISOLATOR

EGEN have made possible aerial isolation in one compact, robust component! Look at these features:

- Minimum space occupied inside chassis
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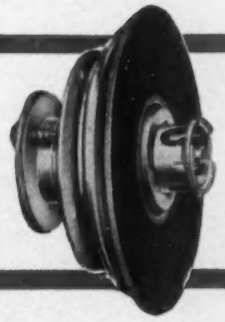
- Complete co-axiality
- Complete effective screening
- Minimum effect on matching of Aerial feeder to receiver
- Insertion loss less than 0.3dB at 50 Mc/s.
- Multi-path resistors giving greater reliability
- All functional elements enclosed and protected against damage
- No soldered joints
- Accepts standard 0.202 in. O.D. co-axial cable
- Component parts are not subjected to heat from soldering iron

EGEN Type 364 Aerial Isolator

The illustration shows the component actual size.



SPECIFY EGEN FOR RELIABILITY

EGEN ELECTRIC LTD

Charfleet Industrial Estate · Canvey Island · Essex

SEE OUR STAND AT THE RECMF

WPS 57

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(. . . a question with many answers)

FOR SKILLED CAPACITY AT LOW COST

Because our business is wholly and solely sub-contracting—we make no products of our own—we can supply highly skilled production capacity as and when required at surprisingly low cost.

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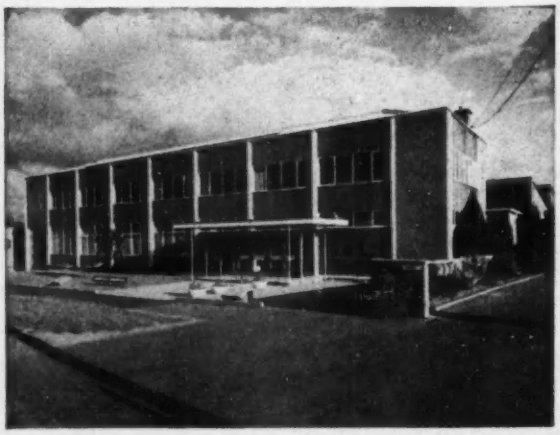
BROXLEA SERVICE

ELECTRONIC MANUFACTURE, ASSEMBLY, WIRING, ETC.



View of the Broxlea Works—14,500 sq. ft. of ultra modern factory space, 15 miles from central London on the A10 road to Cambridge.

Trusted by the people you trust

Below are some famous names —firms who entrust work to Broxlea, and who have kindly permitted their names to appear:

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you will be in good company if you, too, trust Broxlea.

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World in a box

Touch a switch and billions of free electrons bring the world
into your home. Condensers, valves, transistors do the work.
But they have to be mounted, insulated and protected. Here Shell's TGH grade
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make a television set into a piece of furniture of which to be proud.
But television and radio cabinets' escutcheons, control panels
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In all its grades, all its colours, it will suit almost any
injection moulding job you care to name.

CARINEX
POLYSTYRENE

Shell Chemicals

SHELL

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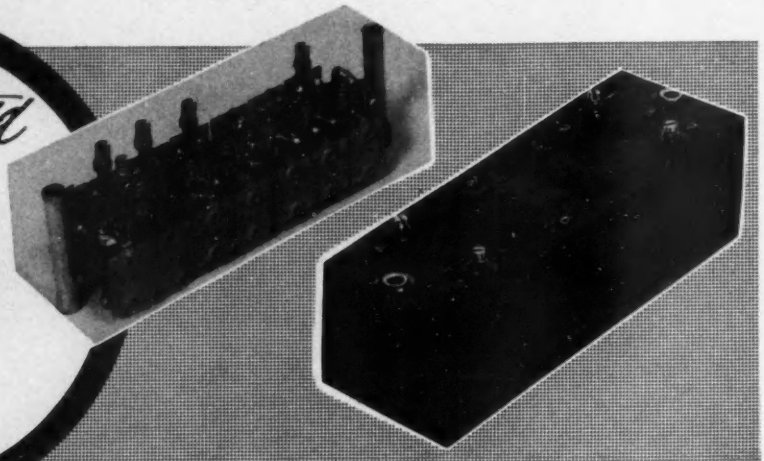
Encapsulated

Delay & Pulse forming Networks



- ENCAPSULATION IN EPOXY RESINS PRODUCES A ROBUST UNIT WITH A SATISFACTORY TEMPERATURE CO-EFFICIENT AND HIGH RESISTANCE TO DETERIORATION UNDER TROPICAL CONDITIONS.
- COMPACT DESIGN MAKES A NETWORK OF 10 μ sec. IN A BLOCK $3\frac{1}{4}'' \times 1\frac{1}{4}'' \times 1\frac{1}{2}''$ (AS ILLUSTRATED) POSSIBLE.
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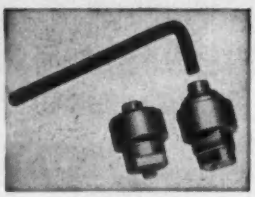
SPECIALISTS IN TRANSFORMERS AND COIL WINDING.

"Q-MAX" SHEET METAL PUNCHES



Patent No. 619178 and Patents pending.

Round, Square and Rectangular. The easiest and quickest way of punching holes in SHEET METAL.

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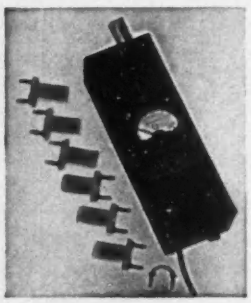
MINIATURE MULTI-WAY PLUGS AND SOCKETS

A full range of connectors from 2 to 33 way, proven in use by the electronic industries of the world.

"Q-MAX" MODEL G.D.O.-2 GRID DIP OSCILLATOR



An ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil mutual and stray inductances and both fixed and stray capacitances. Covers 1.5 to 300 Mc/s in eight ranges. Built in mains pack.
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- 6 shelves per bay—Extra shelves 8/- each.
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THE ONLY HEAVY GAUGE SHELVING AT THIS PRICE

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ASHBURTON RESISTANCE CO., LTD.

INVITE YOU TO

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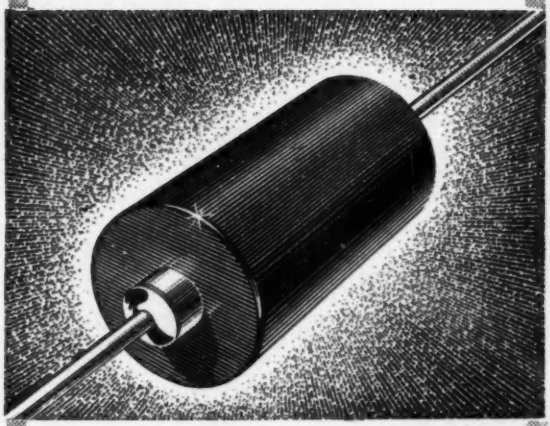
(MAY 30 — JUNE 2)



Displayed will be the full range of Arcol wirewound resistors including the colour graded precision resistor range.

Two new types will be on show for the first time.

ERP 1—*an addition to the precision range.*
It is specificially designed for printed circuit work.

EHD—A new range of enclosed resistors for heavy duty work at competitive prices with a variety of designs.

Delivery.—This is still at two to three weeks from receipt of order.

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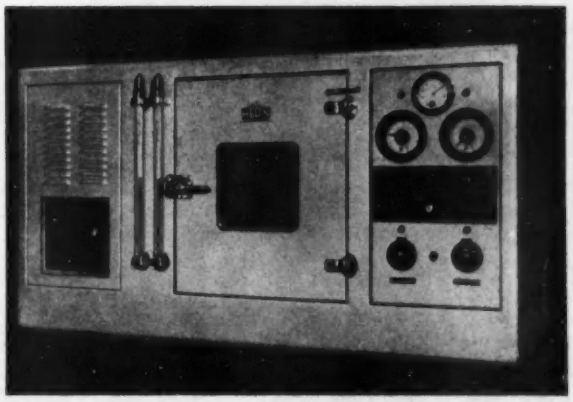
ASHBURTON
PRECISION RESISTORS

HEDIN

HUMIDITY CABINETS

Ministry Approved for Climatic Testing



Catalogue No. 755 R Humidity Cabinet with automatic control and refrigeration.

Hedin Humidity Cabinets have been Ministry approved for both RCS11 and K114 specifications, and are available for (1) climatic testing of electrical and electronic equipment; (2) durability testing of plastics, rubber, paper, chemicals, containers, confectionery and protective coatings.

- ★ **Construction is of stainless steel and aluminium**
- ★ **Automatic control**
- ★ **Standard range of sizes 18″ × 18″ × 17″ to 6′ × 6′ × 6′**
- ★ **Refrigeration available on all models**
- ★ **Non-standard units to special requirements**
- ★ **Designed for easy maintenance**
- ★ **Comprehensive auxiliary equipment available**

We shall be glad to demonstrate a cabinet in our works, or send you our leaflet L. 12

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Tel. BUCKhurst 6601/3.
WORKS: SOUTH WOODFORD & HAINAULT, ESSEX.

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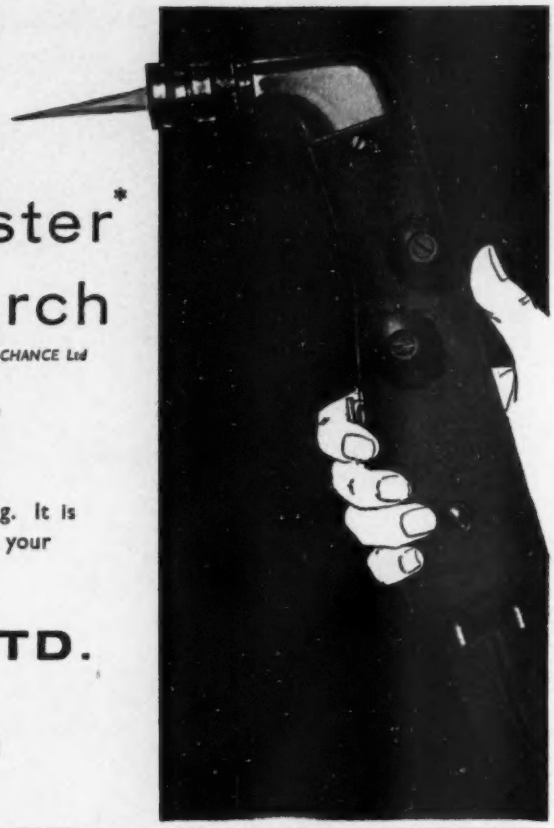

The Flamemaster* hand torch

* *FLAMEMASTER is a registered trade name of STONE-CHANCE Ltd*

The Stone-Chance FLAMEMASTER is now distributed only by *Buck and Hickman Ltd.*

This famous little tool remains unchanged in design and is invaluable for all glass working, metal brazing and soldering. It is made and will continue to be made by Stone-Chance, but your enquiries and orders should now be addressed to :—

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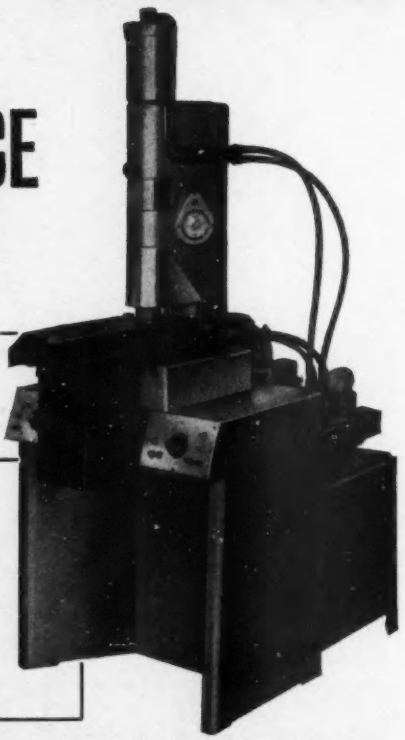
Stone-Chance Ltd., Schomberg House, 82 Pall Mall, London, S.W.1

NEW APM ONE OUNCE

Vertical injection moulding machine



APM 25 range of automatic or hand operated machines

Available in four versions, two fully automatic models powered either by hydraulic or pneumatic units, one hand operated model and one semi-automatic hydraulic machine.
All models are available with interchangeable cylinders of four different bores, are fitted with contact thermometer controls and are capable of fast cycling when desired.

Other popular machines in the APM range include:

APM 28 1½ oz. max. shot, hydraulically operated with improved heating control and operation.

APM 22 ¾ oz. max. shot, hand operated Bench machine.

★ HYDRAULICALLY OPERATED MODEL

FULLY AUTOMATIC

FAST CYCLING

INTERCHANGEABLE CYLINDERS

SEE IT IN ACTION AT THE PLASTICS EXHIBITION STAND A.303 EMPIRE HALL

ASMIDAR PLASTIC MOULDING MACHINES LTD., 10, Tachbrook Street, London, S.W.1. England. Telephone: VICtoria 5554

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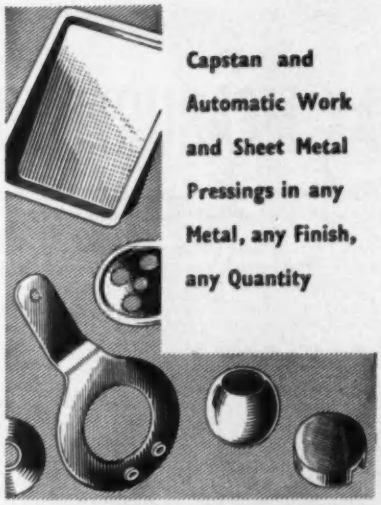

Capstan and Automatic Work and Sheet Metal Pressings in any Metal, any Finish, any Quantity

GRIFFITHS, GILBART, LLOYD,
AND COMPANY LIMITED
EMPIRE WORKS,
PARK ROAD,
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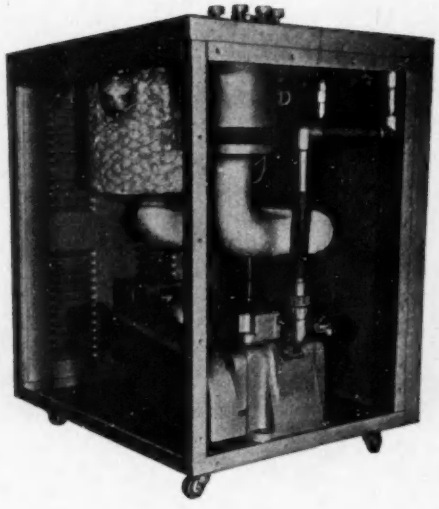
TELEPHONE NORthern 6221

RESIN IMPREGNATION

of wire-wound components under vacuum



N.G.N. new 'Resin-impregnating Plant' not only ensures better and far more thorough impregnation of all types of wire coils—its faster cycle of operation, coupled with carefully designed thermostatic control of vessels and pipework, plus full bore resin transfer valve, all combine to speed output while reducing costs.

Work chamber is evacuated to 1 micron Hg. to degas and dehydrate components which are then impregnated under a pressure of 80 lbs. p.s.i.

Surplus impregnant is completely recovered. Absolute reliability, both as regards thoroughness of impregnation and regular output is assured.

Enquiries for special plant to user requirements are especially welcome.

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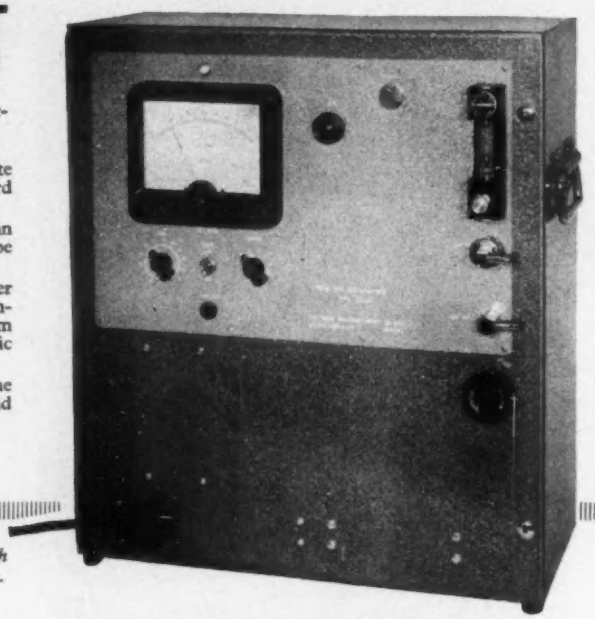
LEAK MEASUREMENT

on sealed components such as fuel tanks and electronic equipment in aircraft and guided missiles.

- Leaks are measured accurately by an absolute method (differential comparison with a standard leak is unreliable).
- Leaks as small as 10^{-2} lusec (less than 0.1 ml/hr) can be located. Leaks two orders smaller can be measured using integration techniques.
- Cheap, easily-obtainable nitrous-oxide is the tracer gas inert, non-toxic, non-corrosive, non-inflammable, non-explosive, and giving no trouble from surface adsorption. An infra-red gas analyser specific to this gas is the measuring instrument.
- 1-, 2-, or 3-range instruments are available, the ranges being 0—100 ppm, 0—1,000 ppm and 0—10,000 ppm.

Please write for details.



Type SC/LC 0–100 ppm self-contained with pump, flow-indicator etc.

INFRA RED DEVELOPMENT CO. LTD

A MEMBER OF THE HILGER AND WATTS GROUP OF COMPANIES

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WELWYN GARDEN CITY
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Shot Blasting

where you want it-
when you want it

Guyson give you versatile Light Industrial Shotblast Cabinets. These virtually self-contained units can be easily moved to any part of the production line, to clean, de-scale or matt-finish components in metal, glass, plastics, ceramics, etc., saving valuable time. The blast gun, operating at pressures from 30-150 p.s.i., will handle abrasives of all kinds from 'fines' to 20 mesh, and special grains for the latest de-flashing techniques on plastics, or metal shooning processes. The Guyson range of machines gives you a wide choice of Bench Models, Floor Models, Sit-Down Machines, etc., covering all phases of light industrial shotblast requirements. Why not send for Bulletin 400-20(C) today and learn how Guyson equipment can help your production.

Illustrated is the Model 400/20.

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For attenuation with

PRECISION

Hatfield

VARIABLE

VHF ATTENUATOR TYPE Q

Designers and Electronic Engineers will welcome this new precision-made Hatfield Attenuator, available for either 0–11dB in 1dB steps or 0–110dB in 10dB steps and covering DC—500 Mc/s. Models are also available for Ledex Drive.

- **V.S.W.R. 1.2 below 250 Mc/s.**
- **Matched at all attenuations.**
- **Low operating torque.**
- **Rated at 0.5 W.**
- **50 ohm and 75 ohm models available.**
- **Size: 5¼ in. × 1⅞ in. × 2⅛ in.**
- **Weight; 1¼ lbs. Price £36.**

The wide range of high quality Hatfield Instruments includes:

- RF Bridge
- Stabilised D.C. Power Unit.
- D.C. Amplifier • A.C. Power Supplies.
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- Coaxial Switches • Valve Millivoltmeter.
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MINIATURE GALVANOMETER RECORDERS

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ZENITH
Reg. Trade Mark

Variac
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the original continuously-adjustable autotransformer

with the Exclusive
Duratrak
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Contact Surface

To provide a portable VARIable A.C. control, this and similar models are available with fuse protection in the output brush line. Terminals can be fitted on the output side as an alternative to the socket outlet.

Catalogue VAR. 5, page 10, shows a useful range, all of which may be fitted with a voltmeter for more accurate reading of output voltage.

Only "VARIAC" has the "DURATRAK" contact surface for longer life and overload capacity.

Model 'V-5HM-PSV'
Input: 240 *volts, 50 cycles*
Output: 0/270 *volts, 2/2.5 amperes*

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Telephone: WILlesden 6581-5 Telegrams: Voltaohm, Norphone, London
MANUFACTURERS OF ELECTRICAL EQUIPMENT INCLUDING RADIO AND TELEVISION COMPONENTS

LEVELL PORTABLE TRANSISTOR INSTRUMENTS

TRANSISTOR TESTER TYPE TM5

Measures the current gains of PNP and NPN transistors, the values of resistances, and the leakage currents of diodes, transistors, and low voltage electrolytic condensers.

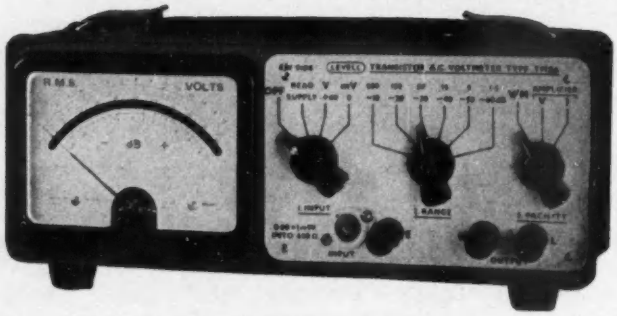
Collector Current Ranges	:	0.5, 5, 50, 500 mA
Current Gain Ranges	:	100, 250, 500
Resistance Ranges	:	0–50k Ω, 0–500k Ω
Price with batteries	:	**£17.0.0**

MULTITESTER TYPE TM1

Transistors and transistor circuits may be tested with this instrument. It contains a transistor 1 kc/s oscillator and a sensitive transistor A.F. voltmeter of 150mV f.s.d. The A.C. current gains of PNP and NPN transistors may be measured at D.C. currents from 0.5mA to 0.5A. Provision is also made for measuring the leakage currents of transistors, testing diodes and resistances, measuring D.C. and audio voltages and the oscillator output.

Price with batteries **£33.1.6**

A.C. MILLIVOLTMETER TYPE TM2A



Measures 50μV to 500V on 12 ranges from 1.5mV f.s.d. Response ±3dB from 6c/s to 250kc/s, ±0.1dB from 30c/s to 30kc/s. Input impedance 1.8M Ω and 20pF on 1.5V to 500V and 0.5M Ω min. and 65pF max. on 1.5mV. Output for C.R.O. Gain up to 80dB available as amplifier with 2V output. Low noise level. Low microphony. No hum. Price with batteries: **£36.0.0**

LEVELL ELECTRONICS LTD.
10-12, ST. ALBANS ROAD, BARNET, HERTS. *BARnet* 5028

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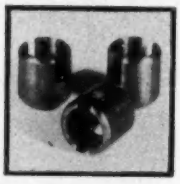
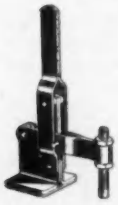
BRAUER "Quick Action" TOGGLE CLAMPS are saving thousands of man-hours wherever they are used in industry. Their fast and effortless action gives powerful accurate holding. Whether you are drilling, milling, welding, brazing, gluing or bonding, etc., in metal, wood or plastic materials. BRAUER "Quick Action" TOGGLE CLAMPS will save you time and money.

FOR QUICKNESS AND POWER USE CLAMPS BY BRAUER

REAMING & COUNTERSINKING



The illustration shows a BRAUER "Quick Action" TOGGLE CLAMP type T.C.70 being used to increase the production rate of reaming and countersinking. Production was in fact increased on this operation from 200 to 500 per hour with the introduction of the "BRAUER" Clamp.



Send now for illustrated catalogue and technical data, to Dept. 14, F. BRAUER LTD., Grove Road, Harpenden, Herts. Tel. Harpenden 3603.

Member of the Cope Allman Group.

BRAUER - makers of Europe's largest range of Toggle Clamps

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IMPROVED CRINKLE SPRING WASHERS

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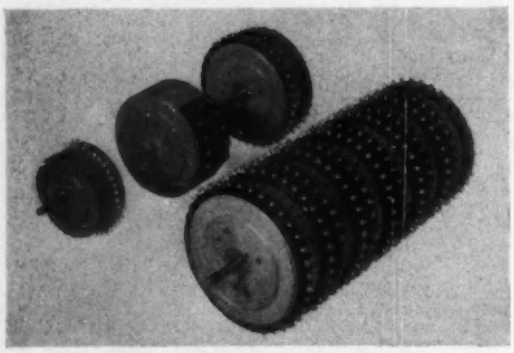

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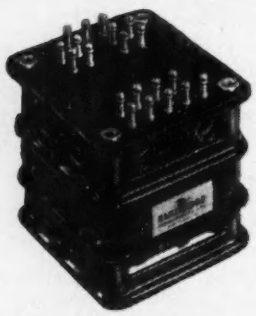

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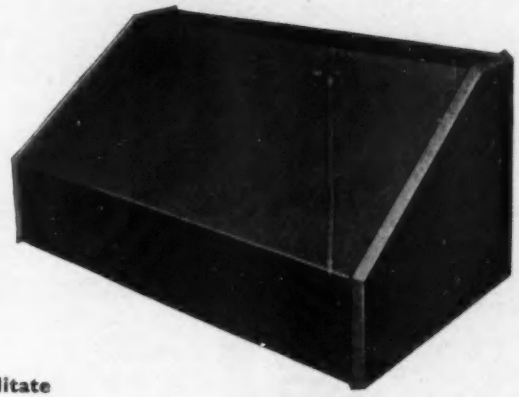

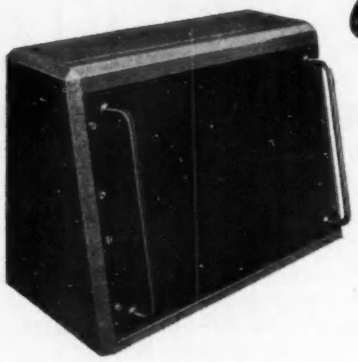

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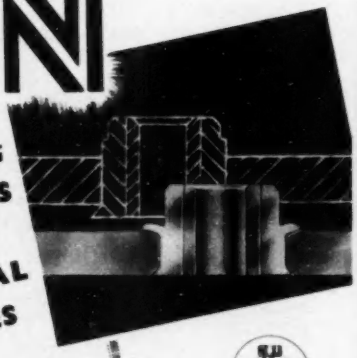

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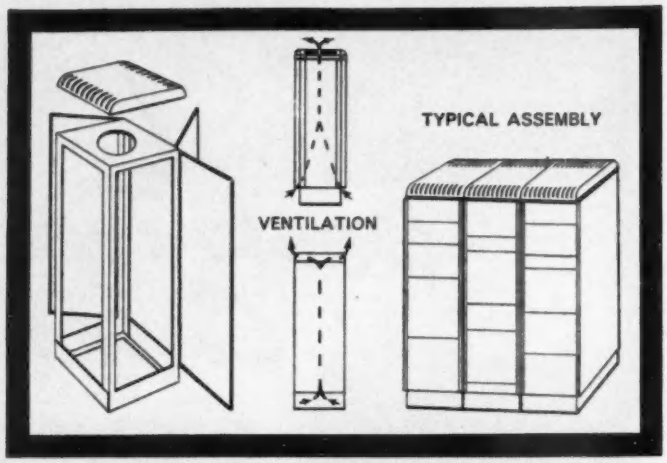

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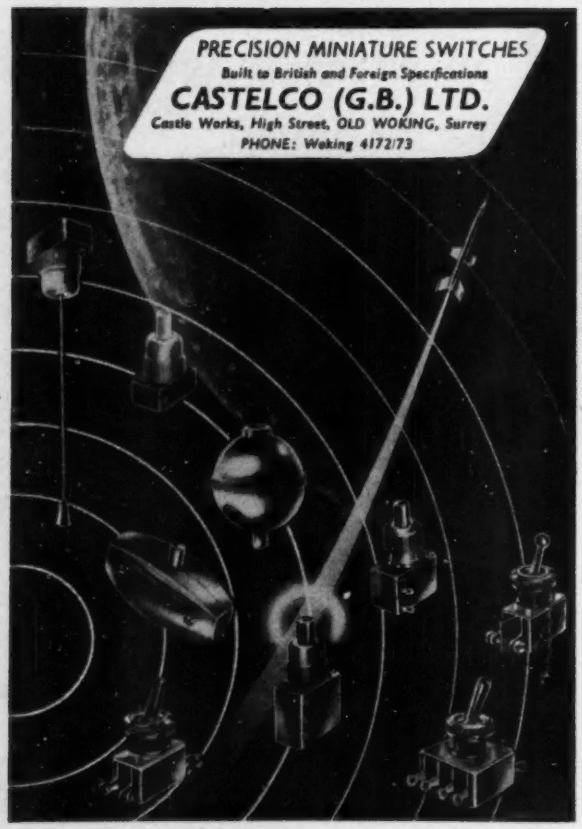
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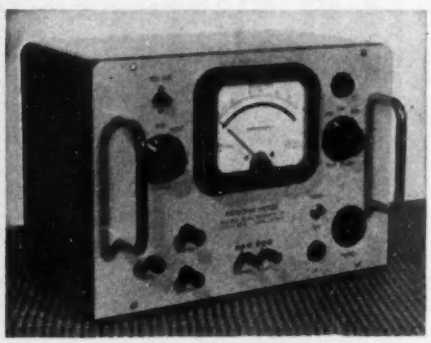

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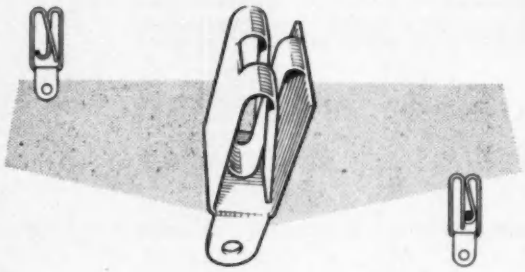

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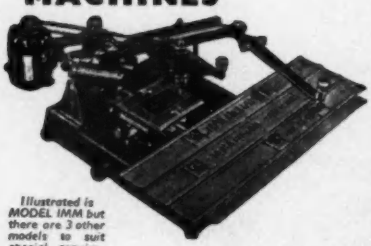

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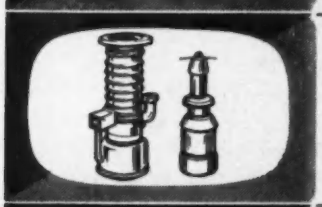

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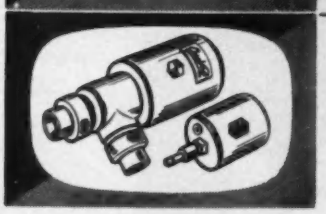

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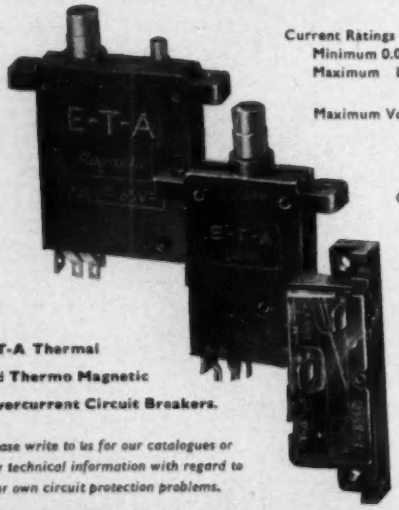

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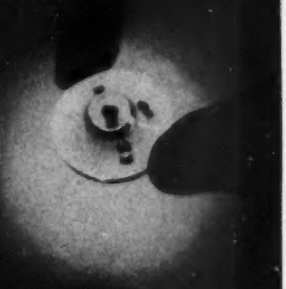

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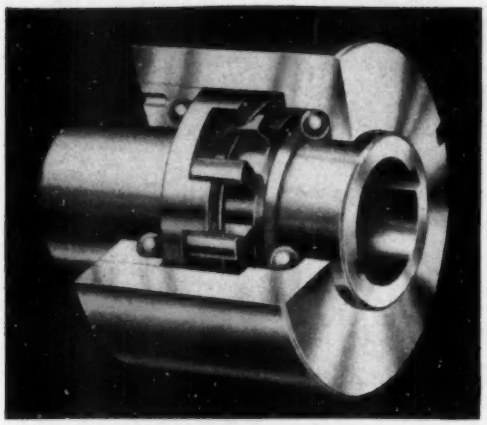

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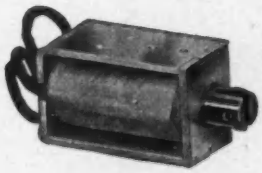

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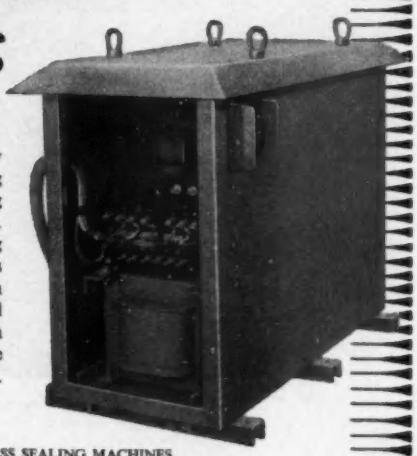

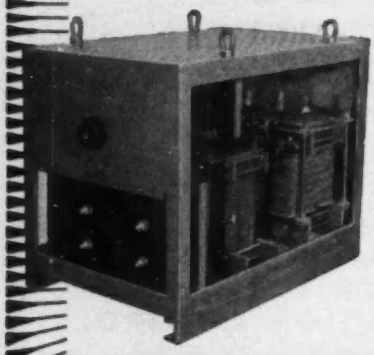

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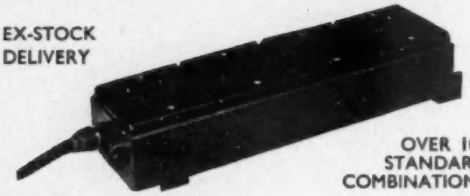

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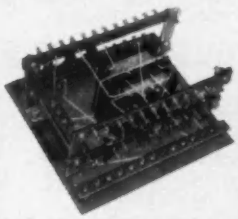

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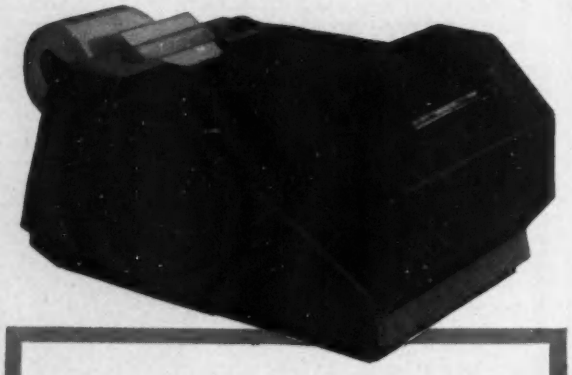

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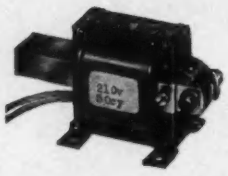

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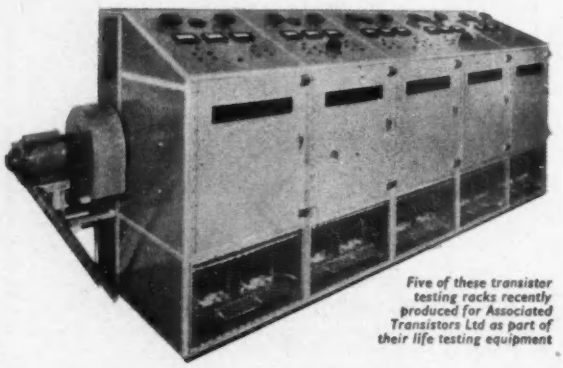

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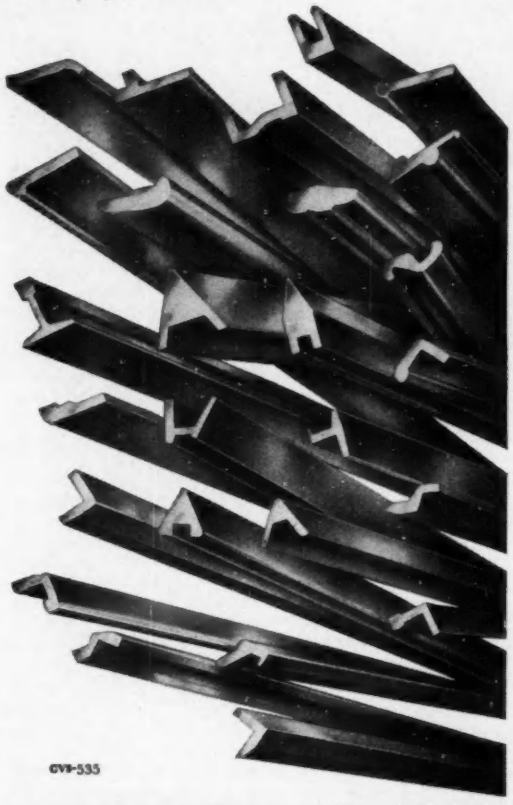

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Classified Advertisement Dept., **"Electronic Engineering", 28, Essex Street, Strand, London, W.C.2.**

OFFICIAL APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD. Eastern Division. Applications are invited for the following permanent Superannuable post in the Central Radiochemical Laboratory situated at Hornsey (North London). Electronic Maintenance Assistant. Salary range £830-£1,065 per annum. The work is interesting and varied and involves servicing instruments employing wide-band amplifiers, counting circuits and the latest techniques in pulse height analysis. Applicants should have several years' experience in the maintenance of industrial or domestic electronic equipment and preferably be familiar with pulse techniques. Preference will be given to those possessing a Higher National Certificate or equivalent qualifications. Applications, quoting reference S.V. No. 1449, stating age, qualifications, experience and present position, should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts., to arrive not later than the 3rd June, 1961. W 5175

MIDDLESEX COUNTY COUNCIL. Education Committee. Brunel College of Technology, Woodlands Avenue, W.3. Principal: Dr. J. Topping, M.Sc., D.I.C., F.Inst.P. Department of Electrical Engineering & Electronics. Senior Lecturer (Electronics); Lecturer (Automatic Control); Assistant Lecturer, Grade B (Electronics). Applications are invited for the above new posts. A good understanding of fundamentals and applications is required; some industrial or research experience is necessary; teaching experience is desirable, but not essential. Every encouragement will be given to undertake research, for which the Department is well equipped. The main teaching will be with Diploma in Technology course. The Department is responsible for the work in Electrical Engineering and Electronics throughout the College. The College, which occupies very pleasant modern buildings, is developing rapidly. Salaries, subject to qualifications and experience, will be in the ranges of: Senior Lecturer, £1,588-£1,801 per annum. Lecturer, £1,408-£1,601 per annum. Assistant Lecturer Grade B, £828-£1,486 per annum. Application forms obtainable from the Registrar at the College. C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5203

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. The Radiochemical Centre, Amersham, Bucks. require an Electronic Instrument Technician for the Instrumentation Section of the Physics Department. The man appointed will be responsible for the calibration and maintenance of the wide range of electronic instruments used for radiation measurements throughout the Centre. Supervisory experience and the possession of a National Certificate would be an advantage. The Centre manufactures and distributes radioisotopes and is situated 25 miles North West of London on the edge of the Chiltern Hills. Salary: £1,060-£1,210. Assisted housing and superannuation schemes; 5 day week. Application forms from The Personnel Officer, The Radiochemical Centre, White Lion Road, Amersham, Bucks. W 5188

OFFICIAL APPOINTMENTS (Cont'd.)

ELECTRONIC SPECIALIST required by University College London (Gower St., W.C.1), for work on development of equipment for automatic measurement of bubble chamber films and nuclear emulsion. Experience in either servo-mechanisms or digital circuits. Salary range, £935—£1,060. Four weeks' holiday. Applications to Secretary, quoting Physics/5, W 5200

LABORATORY SENIOR TECHNICIAN (Physics) Queen Mary College (University of London), Mile End Road, E.1. Salary placing on scale £690×£25—£815 p.a. according to ability. London Weighting up to £45 and possible qualifications supplement of £30 or £50. Pension Scheme. Five day week. Four weeks annual leave. The person appointed will if found suitable be in charge of the electronics workshop. Letters only to Registrar (PST), stating age, full details experience and present work. W 5176

MIDDLESEX COUNTY COUNCIL. Education Committee. Willesden Technical College, Denzil Road, Willesden, N.W.10. Principal: L. L. Allen, B.Sc.(Eng.), A.K.C., M.I.Mech.E., M.I.E.E., M.I.Prod.E. Department of Electrical Engineering. Applications are invited for the following posts: Two Lecturers in Electrical Engineering. Candidates should be graduates with good industrial or research experience and able to teach to post-Higher National Certificate standard one or more of the following subjects: Electrical Engineering, Power Technology, Radio Technology. Ability to teach Mathematics to Final Higher National Certificate standard would be an additional advantage. Two Assistant Lecturers (Grade B). Candidates should be graduates with good industrial or research experience and able to teach Ordinary National Certificate and comparable City & Guilds subjects in Electrical Engineering. Willesden Technical College is a large college situated within a short distance from the centre in London. Engineers interested in an academic career will be given every opportunity and encouragement to continue their studies and to take an active part in research and development projects. Continuous contact with industry is encouraged. Salary: Assistant Grade B within the range £828 to £1,486 per annum. Lecturer £1,408 to £1,601 per annum. Further particulars and application forms (foolscap s.a.e.) from the Clerk of the Governing Body, 163 Willesden Lane, N.W.6, to be returned within two weeks. C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5186

MINISTRY OF AVIATION require Engineer III in the Armament Department of Royal Aircraft Establishment, Farnborough, Hants., to assist in development of fusing devices for airborne weapons and be responsible for the general engineering for production of these devices. Qualifications and Experience: Should have served a recognised engineering apprenticeship and have attained corporate membership of the Institution of Electrical or Mechanical Engineers or possess equivalent qualifications. Experience in use of electronic components and their application to radar and other electronic devices essential and some knowledge of application of plastics desirable. Knowledge of the methods of environmental testing and electrical testing of electronic equipment advantageous. Salary: £911—£1,390 p.a. (Provincial). Starting salary at age 34 and over, £1,218. Not established but opportunities to compete for establishment may arise. Forms from the Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.265/1A. Closing date, 9th June, 1961. W 5198

THE UNIVERSITY OF MANCHESTER. Nuffield Radio Astronomy Laboratories. There are vacancies at the Nuffield Radio Astronomy Laboratories at Jodrell Bank, Cheshire for two Senior Research Assistants to carry out the duties given below: 1. Satellite and rocket experiments to determine the flux, composition radiants and spatial distribution of cosmic dust in the vicinity of the Earth. Successful applicant to take over this project and develop new techniques. 2. Satellite and rocket experiments concerned with investigations of extra terrestrial radio signals over large parts of the r.f. spectrum. Successful applicant to take over this project with ample opportunity for original research. Salaries in the range £800 to £1,000 per annum (with possibility of salaries above the maxima in certain cases). Applicants should hold the degree of Ph.D. in Physics or Electrical Engineering or should have comparable qualifications and experience. Applications should be sent to the Director, Nuffield Radio Astronomy Laboratories, Jodrell Bank, Lower Withington, Macclesfield, Cheshire. W 5179

NEWCASTLE UPON TYNE EDUCATION COMMITTEE, Rutherford College of Technology (Selected for Development into a College of Advanced Technology). Department of Electrical Engineering. The Governors invite applications for the undermentioned posts which arise due to the continued expansion of the Department and to the increased opportunities for research and similar undertakings. In all cases duties will commence on 1st September, 1961. The Department is concerned almost exclusively with advanced courses leading to external degrees, professional membership, H.N.C., H.N.D., Diplomas in Technology and with Post-Graduate courses. Principal Lecturer (1 Post): Candidates should have high academic qualifications together with several years of advanced teaching, good industrial background and, preferably, some research experience. The successful applicant will be responsible for the co-ordination of all studies in power engineering. Senior Lecturer (4 Posts): Candidates should have good academic qualifications allied to sound industrial and advanced teaching experience. The main interests to be covered include one or more of the following: Electrical Measurements, Electronic Circuitry, Electrical Machines, Electricity Supply (High Voltage, Switchgear, System Analysis, System Protection). Lecturer (4 posts: Candidates should be honours graduates with, preferably, corporate membership of the I.E.E. They should have sound industrial experience and be prepared to lecture in H.N.C., Diploma and Degree courses. Salary will be in accordance with the Burnham Technical Report, viz.: Principal Lecturer: £1,750×£50—£1,900. Senior Lecturer: £1,550×£50—£1,750. Lecturer: £1,370×£35 (final £40)—£1,550. Further particulars and forms of application (returnable within 14 days) may be obtained from the Principal, Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, 1. W 5195

NEWPORT AND EAST MONMOUTHSHIRE HOSPITAL MANAGEMENT COMMITTEE. Assistant Engineer required who will be based at St. Woolos Hospital, Newport but will also work at other hospitals in the Group, when travelling time and travelling expenses will be claimable. The successful candidate will be engaged on the maintenance of certain electrical and electronic equipment, and some knowledge of this type of work is required. Salary £655×£20(2)×£30(3) to £795. Write stating experience and two referees to T. A. Jones, Group Secretary, 64 Cardiff Road, Newport, Mon. W 5196

PATENT EXAMINERS and Patent Officers. Pensionable posts for men or women for work on the examination of Patent applications. Age at least 20 and under 29 (36 for Examiners) on 31.12.61, with extension for regular Forces service and Overseas Civil Service. Qualifications: normally a degree, or a Diploma in Technology, with first or second class honours in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C., A.Inst.P. Inner London salary £793 to £1,719; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/128/61, and stating date of birth. W 5182

RESEARCH FELLOWSHIPS in Government Scientific Establishments: Tenable for three years. Value £1,325-£1,640 p.a. (Senior) and £910-£1,220 p.a. (Junior). A very wide range of topics in Physics, Mathematics, Chemistry, Engineering, Biology and other fields. Qualifications: normally first or second class honours degree; evidence of high standard of ability in research; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). Those completing these periods of experience in 1961 may apply. F.S.S.U. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/5244/61. W 5181

THE COLLEGE OF AERONAUTICS. Applications are invited for the appointments of (a) Maintenance Engineer and (b) Assistant Maintenance Engineer for the College's "Pegasus" Computer. Previous experience of computer maintenance is desirable but not essential; candidates without computer experience should be familiar with the maintenance of complex electronic and electromechanical equipment, such as ground radar. Initial salary will depend upon age, qualifications and experience, within the scale £1,000×£50 to £1,500 p.a. for post (a) or £800×£40 to £1,200 p.a. for post (b). Both appointments are superannuated under the Local Government Scheme and post (a) carries eligibility for family allowance. Applications giving full details of experience and qualifications, and containing the names of three persons to whom reference may be made if necessary, should be addressed to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. W 5207

THE COLLEGE OF AERONAUTICS. Department of Electrical and Control Engineering. Physicists and Electrical Engineers are invited to apply for posts as Senior Lecturer, Lecturer, Demonstrator and Research Engineer. Candidates for the academic appointments should have a good honours degree and research, design or teaching experience in an appropriate subject consistent with the seniority of the appointment. The duties of the two senior grades would include lecturing and supervision of student research. Demonstrators are responsible for organisation of teaching laboratories and supervision of students. Excellent facilities are available for personal research. Research Engineers will be required to assist in research and development of equipment. They should have a degree or H.N.C. and be experienced in one of the fields of interest. The vacancies are in: Physics and Electronics Section. Some knowledge of nuclear physics or a good background in electronics desirable. Control and Computation Section. Experience in industrial or process control systems essential. Electrical Machines and Power Section. Some knowledge of machines or power distribution systems for aircraft essential. The salary scales are: Senior Lecturer £1,900×£75 to £2,425 p.a.; Lecturer £1,050×£50 to £1,400×£75 to £1,850; Demonstrator £800×£25 to £1,150, with superannuation under F.S.S.U. and family allowance. Research Engineer, up to £1,650 p.a. depending on grade in which appointed, with Local Government Superannuation, and, in certain cases, family allowance. In each case the commencing salary within the prescribed scale will depend upon age, qualifications and experience. Consideration given to housing requirements. Applications giving full particulars and quoting the names of three referees, to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available. W 5177

UNIVERSITY OF SYDNEY. Chair of Physics (Electronic Computing). Applications are invited for the Chair of Physics (Electronic Computing). The Professor will be in charge, under the general administration of the Head of the School of Physics, of the various branches of Electronic Computing as well as of those members of staff whose work lies mainly in this field. Salary will be at the rate of £A4,250 per annum, plus cost of living adjustments (at present £A36 p.a.). There is retirement provision under either the Sydney University Professorial Superannuation Scheme or the New South Wales State Superannuation Scheme. Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. The Senate reserves the right to fill the Chair by invitation. A Statement of Conditions of Appointment and Information for Candidates may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close, in Australia and London, on 30th June, 1961. W 5178

CLASSIFIED ADVERTISEMENTS

continued on page 228

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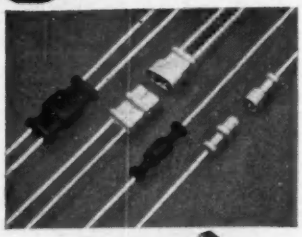

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The plugs and sockets shown are for use in underwater junctions or outside installations. Moulded in Alkathene the loading capacity is 350 volts at 5 amps. max.

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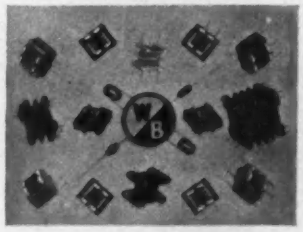
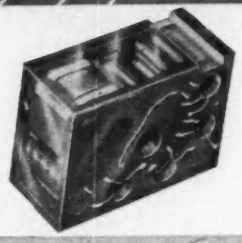


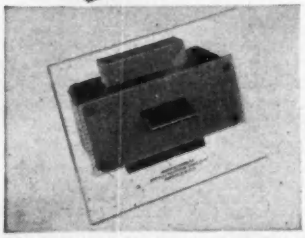


P.O. TRANSISTOR AMPLIFIER

This P.O. Transistor Amplifier moulding is another example of potted components, the illustration is of a development of a miniature version of the amplifier 100A, this model utilising transistors to replace the miniature valves.

PLUG-IN OSCILLATOR

This fixed frequency oscillator is constructed on a standard octal base and encapsulated in epoxy resin. Output: 10 mw into a 600 ohm load. Frequency: as required within the range 700-2000 c.p.s. sinusoidal.



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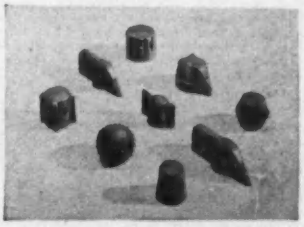

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OFFICIAL APPOINTMENTS (Cont'd.)

ST. GEORGE'S HOSPITAL, S.W.1, Physics Department. Technician or Senior Technician (Electronics) required for the above department. The person appointed would be expected to help in the design and construction of prototype electronic devices and assist in the servicing and repair of such devices as the need may arise. Appointments are subject to the usual conditions with regard to experience and qualifications. Salary range Technician £570-£710, Senior Technician £710-£905 plus London Weighting. Applications enclosing the names of two referees should be sent to Deputy Secretary, St. George's Hospital, S.W.1. W 5187

SITUATIONS VACANT

AN ELECTRONIC ENGINEER is required at the BP Research Centre, Sunbury-on-Thames to work on the maintenance of a variety of electronic instruments and equipment, including mass, infra-red, emission and nmr spectrometers. He should preferably be aged between 25 and 35 with an Electrical Engineering or Physics degree or equivalent experience. This is a responsible post, and the right man should be able to develop improved designs where needed. Salary according to age, qualifications and experience. Non-contributory Pension Fund. Housing Scheme. Removal expenses and settling-in allowance payable in certain cases. Luncheon Club. Write, giving full details and quoting reference H.5484 to Box 6664 c/o Hanway House, Clark's Place, E.C.2. W 5199

DYNATRON RADIO LIMITED require a Senior Circuit Design Engineer with good experience in the design of transistor pulse and fast switching techniques. Apply, giving details of salary and experience to : Personnel Manager, Dynatron Radio Limited, St. Peter's Road, Furze Platt, Maidenhead, Berkshire. W 5202

ELECTRICAL DEVELOPMENT ENGINEER required to initiate and carry out Research and Development work on resistors and heater at Company's Laboratory near Redhill, Surrey. Good salary. Pension. Apply: Research Director, The Expanded Metal Co. Ltd., 16 Caxton Street, S.W.1. W 5191

ELECTRONIC DESIGN/Development Engineer required by expanding Company. Knowledge of supervision on small production runs desirable. Candidates should be conversant with the Services Approved Components system. Degree or H.N.C. standard essential. Knowledge of sound mechanical design applicable to instrumentation an advantage. Salary will be commensurate with the applicant's qualifications and/or experience. Please apply in writing to Technical Director, Kenure Holt Electronics Ltd., Boyn Valley Road, Maidenhead, Berks. W 2032

ELECTRONIC DEVELOPMENT ENGINEER required to lead small team concerned with electronic developments in marine and airfield navigational aids and automatic standby generating equipment. The position calls for a University graduate with a degree in Physics or Electrical Engineering and a successful industrial record, but enthusiasm and all-round ability are of paramount importance. The successful applicant would have every opportunity to participate in the formulation of the development policy of the Company. A salary of not less than £1,750 is envisaged. Applications (which will be treated in strict confidence) giving full personal details, should be sent to the Director and General Manager, Stone-Chance Limited, Gatwick Road, Crawley, Sussex. W 5183

ELECTRONICS ENGINEERS are required for interesting circuit development work. Degree or H.N.C. preferred. Salary commensurate with qualifications and experience. Apply to Electronics Manager, M.P.E. (Finchley) Ltd., Dollis Park, London, N.3. W 5194

ELECTRONIC DEVELOPMENT Engineers required. Experienced in wide Band Amplifiers and Time Bases for Oscilloscopes. Salary commensurate with experience and qualifications, commencing £900-£1,250. Write Dartronic Ltd., 3-7 Windmill Lane, E.15. W 2035

ELECTRONICS. International producers of high grade magnetic materials require a technician. Applicants should be conversant with the properties of these materials and in particular their application in the electronics industry. A university degree in physics coupled with some sales experience would be an advantage. The salary offered will be at least £1,200 according to qualifications and experience. A car will be provided and a non contributory pension scheme is in operation. Applications which will be treated in confidence should be sent to Box W 5193.

ELECTRONIC TEST ENGINEERS AND TESTERS. Light Engineering Company in the Midlands is requiring the above for the testing of Electronic Equipment on Government Contracts and Commercial Television. Applicants with a knowledge of this type of testing, and wishing to obtain well-paid positions, should apply stating qualifications and experience to the Personnel Manager, Box No. W 5151.

JUNIOR ELECTRONIC DEVELOPMENT ENGINEER. Familiar—general industrial electronics circuitry—with some knowledge of chassis and case design, etc. £650-£800 p.a. Staff position, pension scheme—sick club. Write: Grundy & Partners Ltd., 3 The Causeway, Teddington, Middx. W 5135

LOUIS NEWMARK LIMITED, leading company in the design of auto pilots for helicopters are expanding their facilities at their Development Laboratories at Croydon and have the following vacancies to be filled immediately. Engineers and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate with experience. Pension Scheme. Apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark Ltd., Prefect Works, Stafford Road, Croydon, Surrey. W 351

OVERSEAS. Electronic Technicians are required by an Oil Exploration Company with Headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle, and swamp. The equivalent of an H.N.C., with practical experience in electronics, is essential. Tours overseas are of up to two years followed by home leave. Write with full particulars, covering any time spent in the Forces, to Box No. W 356.

MACHINE TOOL CONTROL. A vacancy exists in the Staveley Research Department at Clapham near Bedford for an Electronics Engineer. This Research Department is a member of the Staveley Industries Group and the principal work of the department is concerned with machine tool research and development for the group. One aspect of the work is devoted to applying electronic and data handling techniques to the solution of machine tool control problems and it is in this field of activities that the present vacancy exists. Candidates should be between 25 and 30 years of age. They should possess a suitable honours degree or equivalent qualification and should preferably have had experience in the design and application of logical circuits using transistors. The successful candidate should find ample scope for initiative and progress in a field of activity which presents plenty of problems and plenty of far-reaching opportunities. Replies should be addressed to the Director of Research, Staveley Research Department, Clapham, Bedford. W 5205

PRODUCTION ENGINEER. An outstanding Production Engineer who really knows about manufacturing efficiencies and cost reduction is required by a large Engineering Company to work on the Central Staff of the Chief Executive and operate throughout all Divisions of the Company. He must be a man with high engineering qualifications, skilled in methods engineering and machine tool production, and ever alert to possibilities for cost reduction in a Company which specialises in mass-production techniques. He must be able to mix at top level and advise Directors and Managers on the production aspects of a wide variety of operations in the light engineering and electronic fields. This is an ideal post for a top engineering specialist interested in getting things done, but not in empire building, and supremely efficient at working through others. It is likely that the man will be between 35 and 45 years of age and already earning £3,000 plus per annum. The Company wants the best man in this field in the country. Applications stating age, experience, qualifications, and present salary to Box W 5201.

TEST ENGINEERS WITH AMBITION are invited to apply for an interesting post involving the test and calibration of a wide range of electronic equipment. Previous appropriate experience is essential and technical qualifications would be an advantage. Write in confidence, to The General Manager, Hatfield Instruments Ltd., Burrington Way, Plymouth. Tel.: 72773. W 2036

SENIOR DEVELOPMENT ENGINEER required for work on laboratory and industrial instruments for control systems. Applicants should hold a Degree, Dip.-Tech., or H.N.D. with a sound academic knowledge of control systems and a minimum of 3 years' experience in electronic instrumentation, servo-mechanisms or analogue computing units. Experience in transistor circuit design would be an advantage. The position will involve working in collaboration with consultants and developing basic ideas for instruments to the production stage with the assistance of a small team of technicians. The salary will be about £1,500 p.a. The working location is Crowborough, Sussex. The company is a young one but intends to grow. Apply to the Managing Director, Feedback Ltd., Crowborough, Sussex. W 5126

SENIOR TECHNICAL ASSISTANT required for Development Testing of Prototype Instruments. Some installation and servicing of same, both home and abroad, offers opportunity to travel. Applicants should be preferably of H.N.C. Standard but experience of Industrial Electronics would be favourably considered. Also required Technical Assistant for similar work but to O.N.C. Standard, G.C.E. "A" level, or sound knowledge of basic electronics. Five-day week, canteen, superannuation. Please write to the Personnel Officer, Hilger & Watts, Ltd., 98 St. Pancras Way, London, N.W.1, quoting ref. No. M.18. W 5206

THE RESEARCH & DEVELOPMENT ESTABLISHMENT of Aeronautical & General Instruments Ltd., 105/107 Landsowne Road, Croydon, require Senior Electronics Engineers who should be qualified at least to Higher National Certificate level and/or have a wide and varied experience of present day electronic technique. All applications in the first instance to be in writing to the above address. W 5192

CAPACITY AVAILABLE

SUB-CONTRACT electronic wiring and assembling wanted. Prototype, small batch or regular production runs. Bowers Electromation Engineering Ltd., 209a Hertford Road, Edmonton, London, N.9. HOWard 2231. W 2033

CLASSIFIED ADVERTISEMENTS

continued on page 230

NEW VHF FRAME GRID FREQUENCY CHANGER

EDISWAN MAZDA 30C17
DESIGNED FOR AGC OPERATION

The 30C17 is a new VHF high gain triode pentode frequency changer for television tuners. The pentode section has variable mu characteristics enabling its gain to be controlled from the AGC line.

The application of gain control to the frequency changer stage of a television tuner will greatly ease the cross-modulation requirements of the IF valve since the output from the tuner can be kept lower when two stages are controlled. This leads to improvements in the AGC and cross-modulation performance of the whole receiver. To give the utmost control AGC can be applied to three stages, RF, Frequency Changer and Common Variable-mu IF. Alternatively it offers the possibility of controlling the two tuner valves only and using a straight IF amplifier with its attendant advantage of extra IF gain.

Heater Current (amps)	I_h	0·3
Heater Voltage (volts)	V_h	7·4

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

		Triode	Pentode
Anode Dissipation (watts)	$p_{a(max)}$	2	1·7
Screen Dissipation (watts)	$p_{g2(max)}$	–	0·5
Anode Voltage (volts)	$V_{a(max)}$	250	250
Screen voltage (volts)	$V_{g2(max)}$	–	230
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)rms}$	200	200
Cathode Current (mA)	$I_{k(max)}$	18	18

Inter-Electrode Capacitances* (pF)

Input	c_{in}	3·5	6·6
Output	c_{out}	2·1	3·1
Control Grid to Anode	c_{g-a}	1·8	0·008
Grid Triode to Grid 1 Pentode	c_{gt-g1}	0·01	
Anode Triode to Anode Pentode	c_{at-ap}	0·01	
Grid Triode to Anode Pentode	c_{gt-ap}	0·002	
Anode Triode to Grid 1 Pentode	c_{at-g1}	0·005	

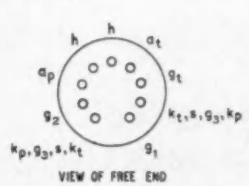
*Measured in fully shielded socket with can.

Triode Characteristics

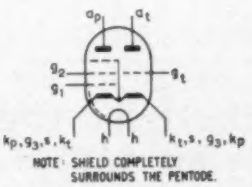
Anode Voltage (volts)	V_a	100
Anode Current (mA)	I_a	15
Mutual Conductance (mA/V)	g_m	8·5
Amplification Factor	μ	20

Base : B9A (Noval) **Mounting Position:** Unrestricted

Connections



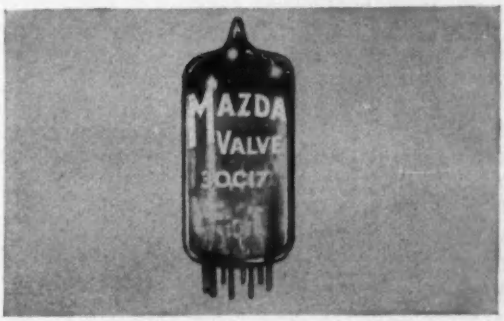
VIEW OF FREE END



NOTE: SHIELD COMPLETELY SURROUNDS THE PENTODE.

Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22·2



TYPICAL OPERATION AT 200 Mc/s WITH CATHODE BIAS

For operation with cathode bias where it is intended to apply AGC to the frequency changer. The oscillator voltage is applied to the pentode control grid.

Pentode		
Supply Voltage (volts)	V_b	200
Anode Voltage (approx.) (Decoupling Resistance, R_a = 4·7 kΩ) (volts)	V_a	170
Screen Voltage (approx.) (R_{g2} = 22 kΩ) (volts)	V_{g2}	155
Cathode Bias Resistance (Ω)	R_k	100
g_1 Resistance (MΩ)	R_{g1}	4·7
g_1 Current (μA)	I_{g1}	0·6
Anode Current (approx.) (mA)	I_a	6·4
Screen Current (approx.) (mA)	I_{g2}	2·0
Conversion Conductance at 1 Mc/s (mA/V)	g_c	4·9
Grid Voltage for Conversion Conductance reduction 10 : 1 (volts)		−6·7
Triode		
Anode Voltage (volts)	V_a	100
Anode Current (mA)	I_a	5

TYPICAL OPERATION AT 200 Mc/s WITH GRID CURRENT BIAS

Operation with grid current bias is suitable for the 30C17 in existing tuners not provided with AGC on the frequency changer. The oscillator voltage is applied to the pentode control grid.

Pentode		
Supply Voltage (volts)	V_b	200
Anode Voltage (approx.) (Decoupling Resistance, R_a = 5·6 kΩ) (volts)	V_a	148
Screen Voltage (approx.) (R_{g2} = 33 kΩ) (volts)	V_{g2}	108
g_1 Resistance (MΩ)	R_{g1}	0·1
g_1 Current (μA)	I_{g1}	24
Anode Current (approx.) (mA)	I_a	9·2
Screen Current (approx.) (mA)	I_{g2}	2·8
Conversion Conductance at 1 Mc/s ($V_{hot(pk)}$ = 2·6 V) (mA/V)	g_c	5·2
Triode		
Anode Voltage (volts)	V_a	100
Anode Current (mA)	I_a	5

Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: Gerrard 9797 Grams: Sieswan Westcent London

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BATTERSEA COLLEGE OF TECHNOLOGY, London, S.W.11. The fifth One-Year Full-Time Course in Control Engineering will commence on 2nd October, 1961. The course is recognised by the D.S.I.R. for the tenure of Advanced Course Studentships and holders of a second class honours degree may qualify for the award of a Studentship. Applications should be submitted to the Head of the Electrical Engineering Department, Battersea College of Technology, Battersea Park Road, London, S.W.11 W 5190

HATFIELD COLLEGE OF TECHNOLOGY. Summer School on the Mathematics of Automatic Control, 26th to 30th June, 1961. Lecturers: Prof. B. M. Brown, Dr. M. J. Cartwright, F.R.S., Mr. J. F. Coales, Dr. A. J. O. Cruickshank, Dr. J. J. Florentin, Dr. A. T. Fuller, Dr. F. R. Himsworth, Dr. S. Katz, Mr. M. J. McCann, Dr. D. S. Mitchell, Mr. P. C. Parks, Mr. W. Spendley, Mr. D. G. Watts and Prof. E. M. Wright. For full particulars apply Academic Registrar, Hatfield College of Technology, Hatfield, Herts. W 5185

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U.K.A.E.A. Harwell Reactor School. Control and Instrumentation of Reactors Course No. 7. To be held at Durley Hall, Bournemouth. Provisional dates 25th September to 6th October, 1961, inclusive. Fee £52 10s. exclusive of accommodation. It is intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and participants are assumed to have some knowledge of the basic principles of these subjects. Application forms and further details for this course can be obtained from: The Manager, Reactor School, A.E.R.E., Harwell, Berks. W 5197

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ELECTRONIC DESIGN, development, prototype manufacture. Sub-contract work undertaken. London area. Box W 2041.

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FOR SALE

ELECTRONIC ENGINEERING, one complete set of unbound copies available, January 1948 to February 1961. Offers invited to W. Hersch, 22, Thistledene, East Molesey, Surrey. W 2040

LEADING DESIGNERS specify "Flexigarde" the flexible plastic coil for conduits, etc., also "Clerefranz" the Self Adhesive clear film for protection. Samples, etc. Crossley, Eastgate Street, Rochdale. Tel. 47272. W 5155

50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 2382). W 357

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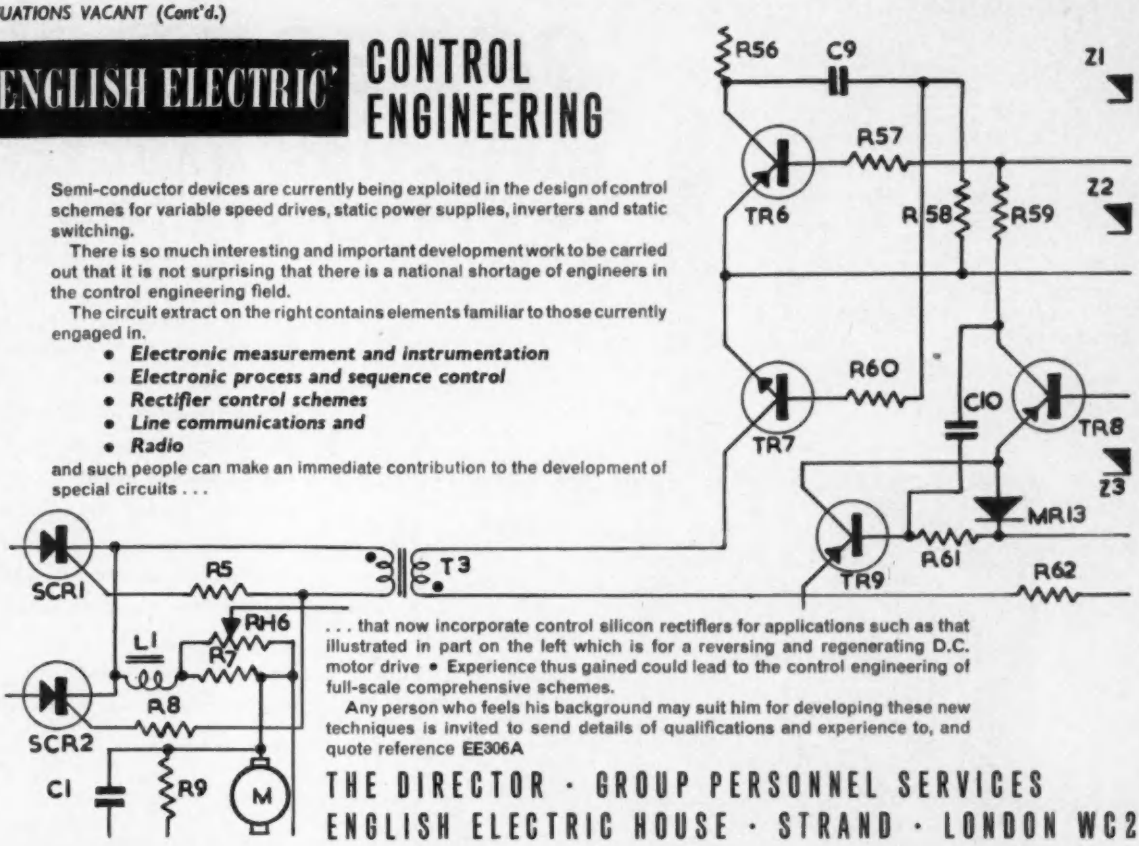

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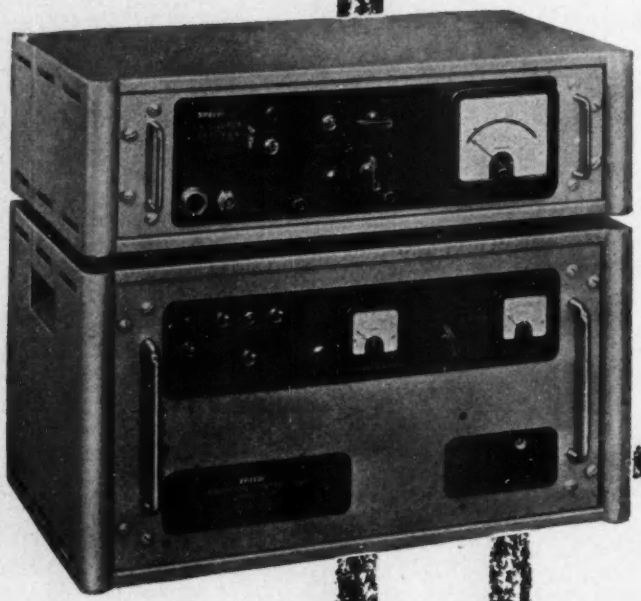

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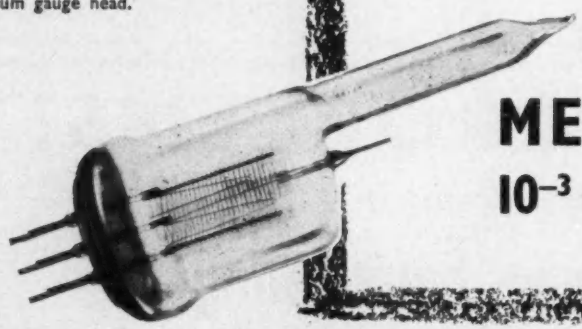

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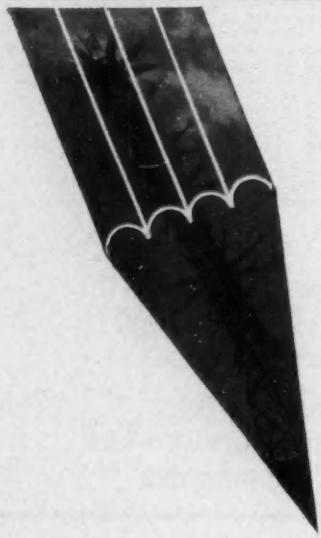

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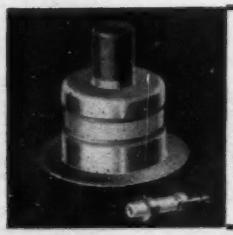

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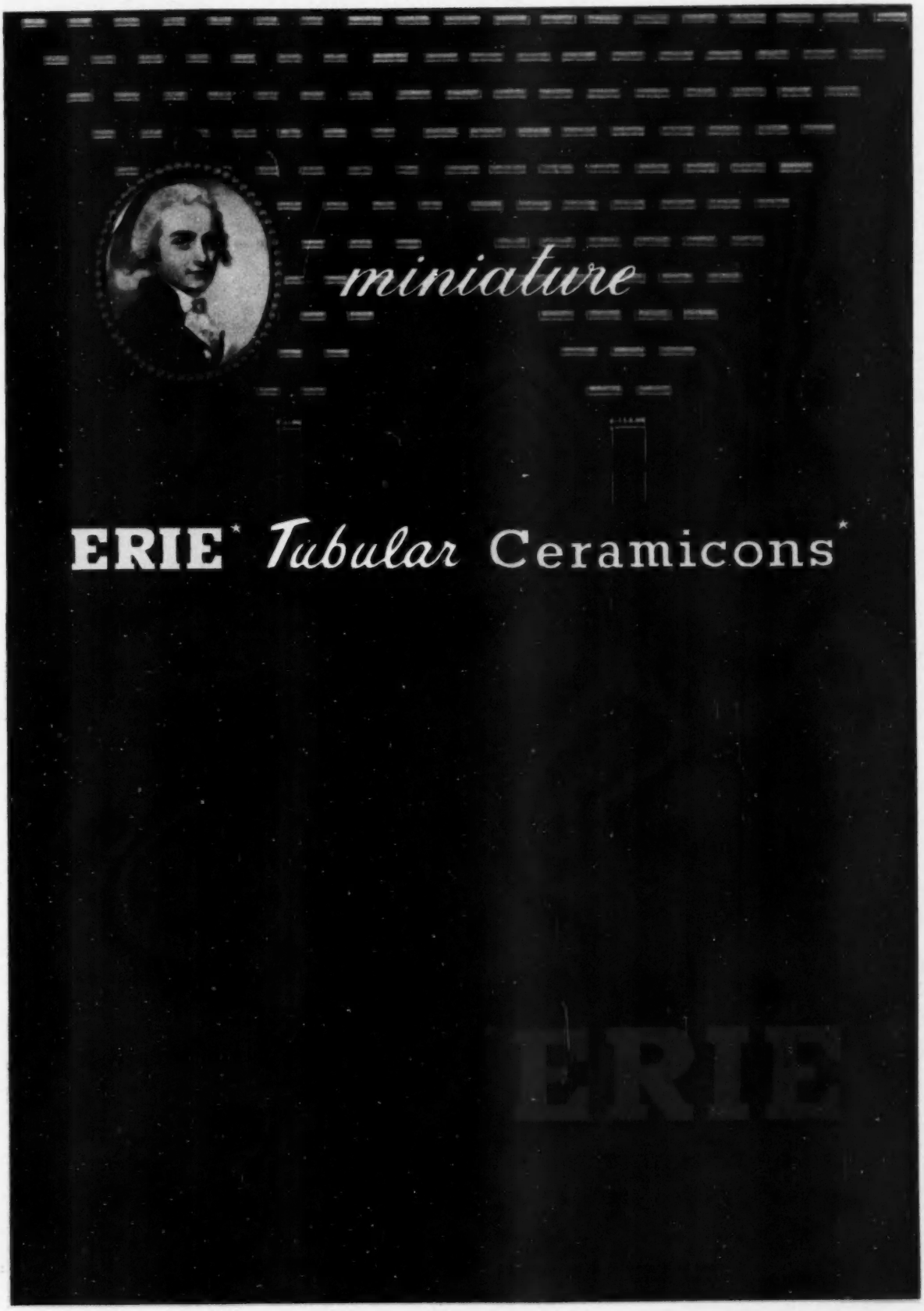

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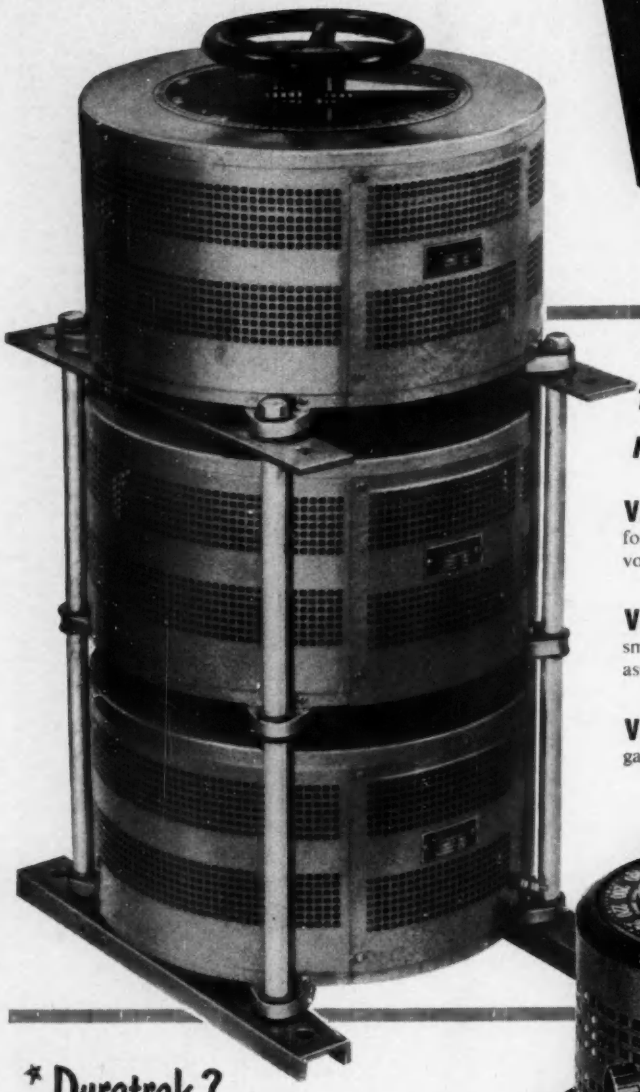

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